Manisa Celal Bayar University Journal of The Faculty of Education
ISSN: 1309-8918

2024, Vol. 12, No:2

Investigation of the Geometry Problems Posed by Secondary School Students Requiring Proportional Reasoning

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Abstract

This study aims to examine the geometry posed problems of secondary school eighth-grade students for proportional reasoning situations. A case study was applied for data collection. The participants were selected by adopting the criterion sampling method from the purposive sampling method. The study participants, which was carried out in the second term of the 2021-2022 academic year, consisted of twenty-five eighth-grade secondary school students attending a state secondary school in Kadıköy, Istanbul. A 6-question geometry problem-posing test was used to collect the study's data. A semi-structured interview was used to learn the students' opinions about their problem-posing situations. The data obtained from the problem-posing test were analyzed according to the study of Güveli (2015). The data obtained from the interviews were analyzed using the classification of Miles and Huberman (1994). According to the study results, much more than half of the problems posed by the students were geometry problems involving proportional situations. It has been observed that the problems posed by the students are non-complex problems frequently encountered in textbooks and can be associated with daily life.

Keywords
1.Problem posing
2. Geometry
3. Proportional reasoning
4. Middle school
5. Problem

Received
14.01.2024

Accepted
30.11.2024

Research Article

Suggested APA Citation:
Öztürk, E., & Kılıç, Ç. (2024). Investigation of the geometry problems posed by secondary school students requering proportional reasoning. *Manisa Celal Bayar University Journal of the Faculty of Education, 12*(2), 458–483. https://www.doi.org/10.52826/mcbuefd.1419606

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Note: This is an article produced from the thesis of first author.

INTRODUCTION

When the problem-posing literature is investigated, it is defined as the capacity to transform an existing problem into a new one or to transform an existing scenario into a new and different problem situation (Silver, 1994; Silver & Cai, 1996). Students may engage in problem-posing activities to connect the knowledge they learned in the mathematics session with other topics and recognize the linkages already in place. Several research have examined the value of posing problems. According to Abu-Elwan (1999), it is crucial to develop both the ability to create and solve mathematical problems. Using problem-posing activities in mathematics learning and teaching activities aids in developing the following skills. Using the table, figure, graphic, operation, rule, result, free situation, or real-world situation provided to the students with their knowledge, experience, and metacognitive skills is expressed as problem-posing since it is a problem-posing technique (Ev-Çimen & Yıldız, 2017). There are numerous reasons why this topic holds significance. Problem posing as a tool for mathematics instruction is regarded as a way for teachers to assist their students in learning mathematics (Cai & Leikin, 2020). According to Van Harpen and Presmeg (2013), there is a correlation between students' mathematical content knowledge and their problem-solving skills. Researchers have utilized problem posing as a research instrument in studies focusing on other aspects of students' learning, reasoning, and creativity (Cai & Leikin, 2020).

Many studies have been carried out to categorize problem-posing actions (Cankoy & Darbaz, 2010; Christou, Mousoulides, Pittalis, Pitta-Pantazi & Sriraman, 2005; Silver, 1993; Stoyanova & Ellerton, 1996). The Stoyanova and Ellerton (1996) classification, which classified problem-posing activities as structured, semi-structured, and free, is the most widely used. According to Silver (1993), students are invited to pose a natural, straightforward problem utilizing their knowledge in the free problem-posing activity. Çelik (2010) claims it is a problem-posing style with no restrictions. Open-ended information is provided to generate a problem using prior knowledge, experience, and experience in the semi-structured problem-posing style. Sometimes, a method is presented, a story is established, or the activity is paired with a plot. Both flexibility and limitation might be noted in semi-structured problems (Kılıç, 2013). Participants are expected to suggest a new problem by providing a carefully thought-out example when presenting organized problems.

Studies using problem posing have attempted to determine the proportional reasoning status of secondary school students and preservice teachers (Ada, Demir & Öztürk, 2020; Çelik & Yetkin-Özdemir, 2011; Kırnap-Dönmez, 2014; Turhan-Türkkan, 2018). According to Van De Walle and Karp & Bay-Williams (2012), proportional reasoning is a method of reasoning about multiplicative situations that calls for more understanding than simply setting proportions for issue solving. Because of this, proportional reasoning is one of the most essential ideas in classroom mathematics, according to Lesh, Post, and Behr (1988). Students are expected to understand proportional reasoning because it is essential for understanding many mathematical concepts, including ratio-proportion. This is why it is crucial to highlight proportional thinking in a way that does not lead to misunderstandings. The most crucial component of the essential infrastructure for learning advanced mathematical concepts in high school mathematics curriculum is the ability to use proportional reasoning when learning various mathematical concepts at the primary school level (Lesh et al.,1988) fifth-grade through eighth-gradeThe elementary school mathematics curriculum has as one of its primary goals the development of students' proportional thinking abilities (Van de Walle et al., 2012). As pupils are in secondary school, reasoning scenarios that they often solve using adding operations are replaced by reasoning situations involving multiplication that call for an understanding of proportional change (Baxter & Junker, 2001). According to Wollman and Lawson (1978), proportional reasoning is a crucial mathematical tool for comprehending biology concepts like the genetics of living systems as well as physics and chemical concepts like power, pressure, velocity, mixing, momentum, and density. For that reason, proportional reasoning is a type of reasoning that we utilize both consciously and unconsciously throughout the day. Whether completing daily tasks like grocery shopping, calculating exchange rates, cooking in the kitchen, or performing house renovations, we engage in these mental processes either consciously or unconsciously (Tourniaire & Pulos,1985).

According to NCTM [National Council of Mathematics Teachers] (1989), proportional reasoning encompasses the capacity to work within proportionate contexts and the ability to consider proportional relationships, locate equations, and construct graphs and tables. For this reason, MoNE [Ministry of National Education] (2009) established proportionality as a concept in the mathematics curriculum for secondary schools as a crucial skill to be acquired in linear equations, the relationship between the diameter and circumference of a circle, and scale calculations. Another measurement area for improvement in national and international tests is students' capacity to relate proportional circumstances to other disciplines. According to Van de Walle et al. (2012), mastery of many eighth-grade math concepts, including slope, similarity, probability, and data analysis, is based on proportional reasoning. In this instance, it is vital to emphasize the significance of proportional reasoning, given that national and international tests designed to assess students' proficiency in mathematics are held mainly at the eighth-grade level.

The subjects of slope, trigonometry, triangles, quadrilaterals, and similarity relate to proportional reasoning. The similarity between these topics is significant, particularly in the mathematics curriculum for secondary schools. Making maps, scaling, manufacturing scaled-down toys, enlarging or constricting photos, and resizing photographs are everyday tasks (Lehrer, Strom & Confrey, 2002). Piaget (1966) proposed using the concept of similarity to examine pupils' understanding of proportion and how geometry and spatial relations are combined. Both shape perception and discussion and interpretation power should be cultivated for children to comprehend similarities (Cox, 2008).

The Significance of the Study

According to the study by Geçici and Türnüklü (2020), problem-posing studies became increasingly popular in Turkey, particularly after 2005. However, even though these studies were typically conducted at the secondary school level, there were surprisingly few that focused on the subject matter of geometry and measurement. Based on the literature, this study is necessary to determine how the pairing of proportional reasoning with the geometry-learning environment influences the students' problem-posing status. Geometry and proportional thinking have both been the subject of studies, although none of these studies have been located. The ability of students to apply proportional situations in geometry issues and to formulate questions are seen in this study as crucial to the realization of learning by rearranging information. The project is expected to help pose problems for learning geometry, explain proportional reasoning scenarios using geometry problems, and pinpoint issues with students' understanding of these topics.

In the eighth grade, topics like slope, congruence, and likeness in triangles relate to proportional reasoning. A very essential topic in the high school mathematics curriculum is triangle similarity. Piaget (1966) proposed using the concept of similarity to ascertain what and how children comprehend the concept of proportion. Knowing the proportional circumstances that students regularly run across daily can help students learn more quickly and will let the teacher know how the learning process is going. According to Taylor and Jones's (2009) analysis of the literature studies, the surface areas and volumes of things have a multiplicative relationship, and this topic should be taught using circumstances requiring proportionate thinking. Tolga and Günhan (2020) challenged eighth-grade students to identify similar and congruent triangles from a set of mixed triangles as part of their research. He saw that although the kids could use the parity of the angles, they had trouble connecting the sides. In this way, students are expected to construct fresh and unique circumstances using their observations and knowledge from many domains when problem-posing is taught as a lesson. In Geçici's (2018) study, eighth-grade students had difficulties posing a geometry problem, and he recommended that students practice posing geometry problems. Çelik (2010) found that students with low levels of proportional reasoning had difficulty posing a ratio-proportion problem. The research focused on middle school student's knowledge of proportionate situations in geometry issues since it was assumed that they would retain and use proportional situations in similar difficulties based on the literature studies. The study is significant for analyzing how students employ ratio-proportion concepts in geometry classes and accurately presenting the relationships between concepts. Giving students exercises in proportional thinking was intended to increase their awareness of proportional circumstances. This awareness was then assessed by having them solve geometry problems. It is well recognized that proportional circumstances in the study of geometry have an impact on math course outcomes, particularly for students in the eighth-grade. Early recognition of this by the student and their discovery that buildings are constructed using proportionate reasoning demonstrate their ability to make connections between the subjects. Because of this, it is evident from the literature reviews that there has been a lot of effort on issue posing, particularly in recent years (Ada, Demir & Öztürk, 2020; Çelik, 2010).

Research Questions

By evaluating the geometry problems presented by the eighth-grade students for the situations requiring proportional reasoning abilities, this study was created to find out the problem-posing circumstances of the students and their opinions on the procedure. By this general purpose, answers were sought to the following questions:

1. How do the eighth-grade pupils pose geometry problems regarding proportional situations?
2. How do the eighth-grade pupils feel about how proportional geometry problems are posed?

METHOD

Research Design

This investigation is set up as a case study. A holistic approach is used to address factors about one or more circumstances, and extensive research is done on how the pertinent issue impacts and is influenced (Yıldırım & Şimşek, 2018). The study was conducted with eighth-grade students in the public school where the researcher works. Studies on proportional reasoning were carried out with the pupils once a week for 4 weeks. Studies on proportional reasoning were conducted to raise students' knowledge of ratio and proportion concepts and real-world situations that appear to be proportional but are not. Following the proportional reasoning study, the students were required to complete a geometry problem-posing test that featured four proportionate scenarios: two structured, two semi-structured, and two free. Nine pupils in total were interrogated due to the test scores presented. The data were explained using content analysis and descriptive statistics because the goal of students' problem-posing scenarios and the interview results was to reveal the current condition. This approach thoroughly explored the students' difficulties and the process of posing problems.

Research Group

The study sample consists of twenty-five eighth-grade students, thirteen females, and twelve boys, attending a public school in the Kadıköy area of Istanbul during the academic year 2020-2021. The study was conducted using a convenient alternative to the deliberate sampling method. Convenience sampling promotes efficiency and practicability in research. (Yıldırım & Şimşek, 2018) The researcher may want a situation that is nearby and convenient to access. One of the reasons why the study was conducted with eighth graders is that children are exposed to various challenges, as national and international examinations are usually administered at this level. This situation demonstrates that pupils can generate a vast array of problem kinds when generating difficulties.

The students who were interviewed were chosen using a criterion sampling technique. In the procedure of criterion sampling, the sample that meets the predetermined criteria is chosen. The researcher determines the criteria indicated in this section (Yıldırım & Şimşek, 2018). In this study, the problem-posing exam scores of the students (low, medium, and high) were considered while selecting students for semi-structured interviews. Low-scoring pupils were classified as D1, D2, D3, intermediate-level students as O1, O2, O3, and high-scoring students as Y1, Y2, Y3. Three students from each group who wanted to participate in the study were selected.

Data Collection Tools

In the study, the problem-posing test (PPT) prepared by the first researcher was used to determine the students' problem-posing performance in geometry learning. In addition, qualitative data were collected using the semi-structured interview form prepared by the researcher himself to assess the PPT applied in the research and the student's views on the application. Each data collection tool is described in detail below.

Problem Posing Test (PPT)

The researcher developed the PPT to assess the problem-posing abilities of eighth-grade students participating in the geometry learning study. Before preparing the PPT, secondary school mathematics textbooks (MoNE, 2020) were studied, and a literature review on problem posing in learning geometry was undertaken. Examining the mathematical curriculum of the MoNE (2018) resulted in six problem-posing questions covering the acquisitions of similarity and slope in the triangle, the sub-learning area of eighth-grade geometry courses. It was composed of free, organized, and semi-structured problem-posing settings, as Stoyanova and Ellerton (1996) suggested. The problem-posing test was conducted after obtaining the opinions of two academics who are experts in mathematics education about its comprehensibility, originality, suitability for learning outcomes, and measuring purpose. There were a total of 9 questions in the problem-posing test. In the problem-posing test, two free, 2 semi-structured, and 2 structured questions were included according to the Stoyanova and Ellerton classification, in line with the opinions received from mathematics educators. One free, one semi-structured, and one structured problem-posing situation was removed from the problem-posing test because of similar questions.

Interview Form

Interviews are one of the data-gathering methods used in qualitative research (Yıldırım & Şimşek, 2018). The qualitative data collection interview aimed to determine the students' perspectives on posing a geometry problem requiring proportional reasoning. Eleven interview questions were included on a form to be completed during the interview. After obtaining the opinions of two academics who are mathematics education experts, the questions' expression and student-level appropriateness were assessed. The prepared interview form was piloted with nine students; the questions that the students could not comprehend were altered, and expert opinions were incorporated before the form was finalized. It was asked about the definitions of ratio and proportion.

Data Collection

Before beginning the project, authorization to conduct research was received from the Istanbul Provincial Directorate of National Education, the İstanbul Medeniyet University's ethics committee, and Güveli (2015) for the Skill-Based Problem Posing Test evaluation scale. The study could begin when the parents of the students participating in the study gave their informed agreement.

The problem-posing test has been designed as a two-lesson-hour application. The PPT's implementation period, which covers the accomplishments of the geometry learning area's geometry, parity-similarity, and slope in triangles, one of the eighth-grade mathematics course subjects, was set at two-course hours. The students completed four weeks of proportional reasoning practice exercises—one hour each week—before administering the problem-posing test. By showing students various applications and having them discuss them, proportional reasoning studies aim to raise students' knowledge of proportional thinking while also educating them about common misconceptions. A problem-posing test was administered after a four-week proportionate awareness research (40+40=80 minutes).

Pilot Study

The PPT and interview questions underwent the pilot application process. Ten students, five boys and five girls, participated in the pilot project, whose socioeconomic status and academic performance were comparable to the leading student group to be used in the spring semester of 2020–2021. The researcher reviewed the definition of problem posing and the desired outcome of posing a problem with the students before the application. The students were given six problem-posing questions during the pilot project, which lasted one lesson hour (40 minutes). However, they received feedback that the time was insufficient. Based on the input given, the primary study was scheduled for two lesson hours (40+40=80 minutes). The explanations for the questions that the students did not understand were revised, and the test was then adjudicated by consulting an expert. For instance, "have you ever had any experience with problem-posing exercises?" In addition to the question "Can you explain which subject or subjects?", a question was added. The same students were used for the pilot interviews for the semi-structured interview form. Also, the interview questions were rewritten, given their final shape, and made plain and understandable.

Implementation Process

With 25 eighth-grade students and one lesson hour over four weeks, proportional reasoning studies were carried out as part of the actual implementation process of the research, taking into account the expert opinion and the circumstances encountered during the pilot implementation process. The application study for PPT was conducted as a 40+40 minute session in the week that followed the study's conclusion. Nine students were interviewed face-to-face using a semi-structured interview form based on their average results after completing the PPT scoring. The interviews were voice-recorded. The interviews took about 15 to 20 minutes. Four weeks they were passed before the interviews were finished. Instead of being given their true identities after the interview, those with poor results were given the codes D1, D2, and D3, while those with medium scores were given the codes O1, O2, and O3, and those with good scores were given the codes Y1, Y2, and Y3.

Data Analysis

According to the situation in which the problem-posing test and the semi-structured interview form were administered, the study's results were analyzed under two distinct topics. Problem-posing circumstances were assessed using the problem-posing test and the Güveli (2015) evaluation rubric. In this study, the Miles-Huberman approach was used to analyze and interpret the data acquired from the semi-structured interview form to investigate the geometry challenges posed by eighth-grade students in scenarios requiring proportional reasoning. Miles and Huberman's (1994) model has three steps. These three phases include data reduction, results display, and formatting. The essential application strategies are the first two steps, which involve the reduction and presentation of data, coding, and note-taking, and are the factors that make the data comprehensible. The data coded into a particular framework are turned into explanation sets, changing the simplified data into a more comprehensible format (Baltacı, 2017).

On the other hand, note-taking can be a paragraph or a few-page review containing coding, data visuals, the researcher's remarks, and biases. Note-taking is not a phase but can be an ongoing practice from the beginning to the finish of a study. After the process, the researcher's subjective interpretation backs the simplified and coded data and draws a conclusion. In the closing phase, the researcher might make the data visible by creating tables, images, concept maps, conceptual clusters, and themes (Eysenbach & Kohler, 2002), quoted in (Baltacı, 2017). In the last phase of qualitative data analysis, supporting literature should be used to confirm the conclusions.

Analysis of the Data Obtained from the Problem Posing Test

Using a graded rubric developed by Güveli (2015) to evaluate problem-posing skills, a teacher and a mathematics educator scored three randomly selected problem-posing papers according to the criteria. Comparing the evaluation results, it was discovered that 98 %.

The students' real names were not utilized in the study; they were given designations 1, 2, 3, etc. Students' responses were graded and grouped by assigning code numbers. The student's problem is "1.1 not the required problem type," "1.2 incomprehensible," and "1.3 irrelevant." If it includes one or more of the "1.4 missing information" criteria, it was deemed incorrect and deducted 1 point. If the problem presented by the student is logically inconsistent, related to different topics, inconsistent, contains incomplete sentences, repeats unnecessary information, or uses unnecessary sentences, it is categorized as "partially correct" and given 2 points after the codes listed in the table are carefully examined. The problem was deemed "right" and awarded 3 points if written using codes such as consistency, logic, orientation to the intended problem type, relevance, no missing sentences, consistency, understandability, and lack of repetition of superfluous information or needless sentences. The Güveli (2015) problem-posing evaluation rubric was applied. Three students with low, medium, and high level average problem-posing test scores were chosen based on the scoring rubric, and nine students were questioned utilizing the "problem-posing interview form." Direct quotes from the students' answer sheets were used to bolster the statistical data and broaden the research's internal validity. The student's numerical code and question type code have been added to make it easier to identify whose student the quotations belong to. While discussing the students interviewed, the low-level students were referred to as D1, D2, and D3, the medium-level students as O1, O2, and O3, and the high-level students as Y1, Y2, and Y3. It was unnecessary to include the success averages in the study because the students' problem-posing test results were in line with the academic accomplishment levels of the school.

The SPSS-22 package program was used to import the data from the PPT. Making figures and tables allowed for the extraction and explanation of the percentage and frequency values of the data transferred to the software. According to Güveli (2015), the problem-posing skill exam was graded, with each "right" response receiving three points, a "partially correct" response receiving two points, and a "wrong" response receiving one point. The highest score that could be attained on the problem-posing skill test was 18, according to an analysis of the results.

Analysis of the Data Obtained from the Semi-Structured Interview Form

Data dumps were done after the interviews were recorded. While coding the data, assistance from a mathematics educator was needed. Coding the data individually allowed for the calculation of encoder reliability. Miles & Huberman's (1994) reliability formula (Reliability = Consensus / (Consensus + Disagreement) was used in the analysis of qualitative data, and the agreement rate between the coders was found to be 95%.

FINDINGS

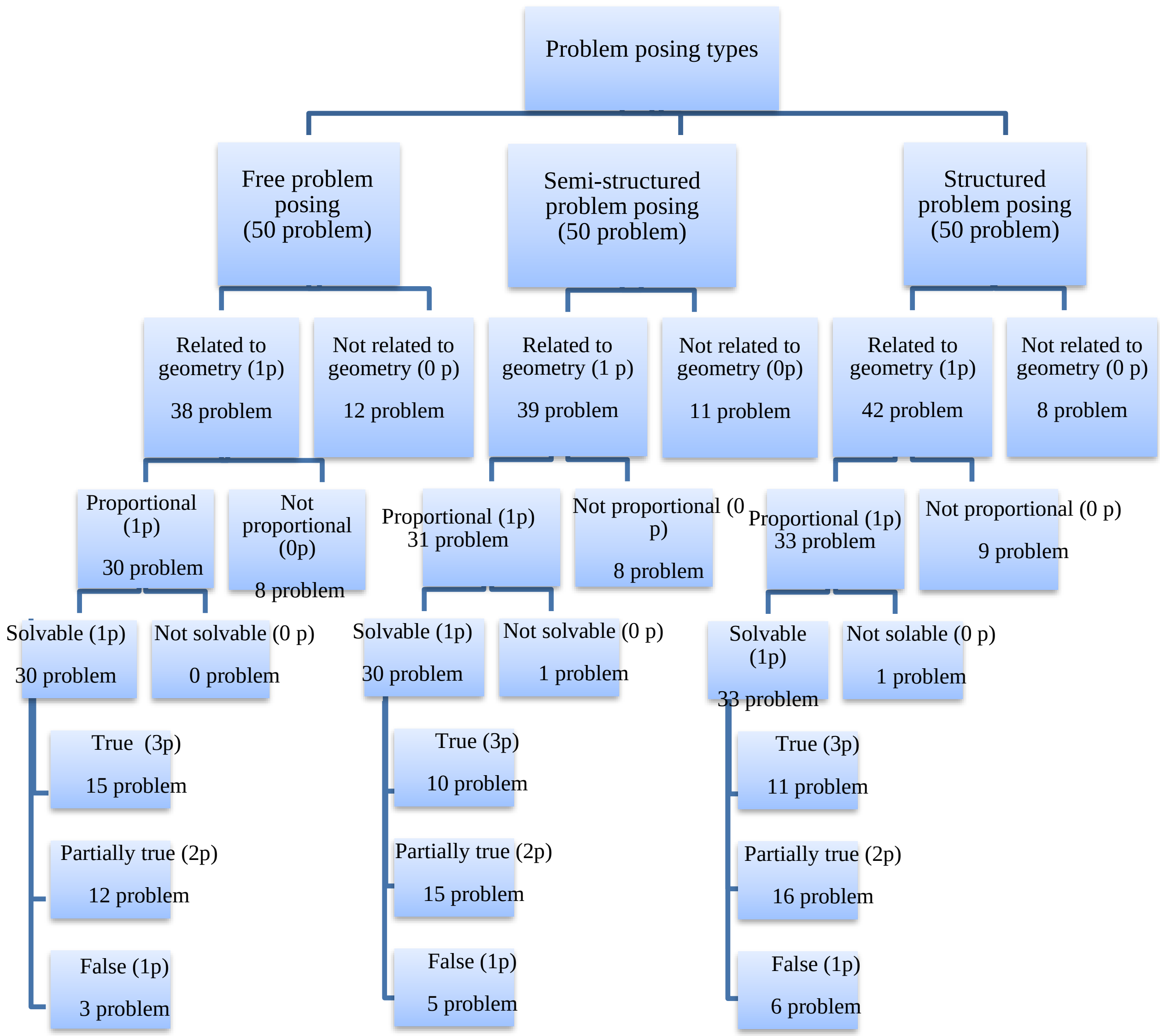


Figure 1. Frequency Values of Problems Posed by Students in PPT According to Problem Types

As shown in Figure 1, the students' posed problems are explained separately as free, semi-structured, and structured problem types. Participants posed a total of 150 problems. All participants tried to pose problems using problem-posing situations. A total of 119 geometry problems, 38 in the free problem type, 39 in the semi-structured problem type, and 42 in the structured problem type, were developed after a preliminary examination to determine whether the problems were geometry problems. According to the scenario of being a geometry problem, most problems formed are structured. The problems that were determined to be associated with geometry were analyzed independently according to the problem kinds.

Results of the Study of Geometry Problems in the Context of Proportional Situations That Students Presented

Students had to complete two structured problem-posing tasks for the researcher's test on problem-posing skills. Structured problems underwent independent analysis.

- **Structured problem posing situation 1:** The students were asked to develop a dilemma comparable to the one below. By arranging the results into tables, it was attempted to explain the outcomes from the problems examined according to the student's level.

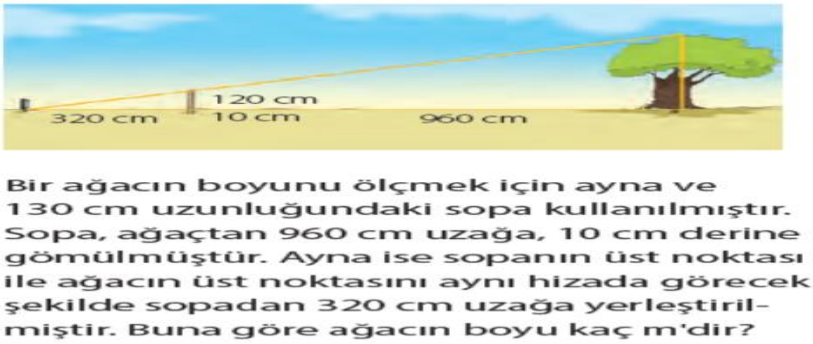


Figure 2. First Structured Problem Posing Situation in PPT

The structured problem presented in Figure 2 above is a sample problem from the MoNE textbooks. It was created as the first problem for the problem-posing skill test. Using the problem will allow us to assess the student's comprehension of and ability to apply proportional situations in triangle similarity in the geometry sub-learning area.

The students' answers were evaluated, and it was discovered that each student attempted to construct a problem and could describe it. Students with the names D1, D3, and O1 used different types of problems unrelated to the desired instruction, while students with the names D2, D3, O2, O3, Y1, and Y3 used the given instruction while creating the problem. It was found that students with the names D2, O2, O3, Y1, Y2, and Y3 created a different problem similar to the example. Each kid came up with a unique example. Only the students with the names D2, O1, O3, and Y1, Y3 detected the problem's similarity issue, and only the students with the names O3, Y1, and Y3 correctly employed similarity in their problems. Figure 3 shows the solution provided by student Y3 to the first structured problem-posing situation.

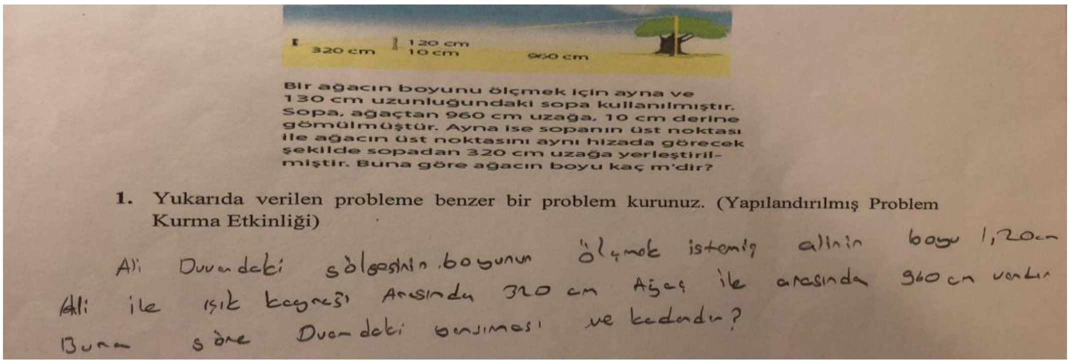


Figure 3. Example of Structured Problem Established by Student Y3 (first situation)

In Figure 3, it has been determined that the Y3 student's structured first problem-posing situation is appropriate for the required problem-posing situation; the student's perspective on the problem situation is provided below:

Researcher: Could you explain step by step what you did when posing a problem?

Y3: I started by looking at the shape. I then reviewed the questions I had previously answered, and this problem appeared.

Y3 stated that he considered daily life while posing a problem.

Just D1 of the students claimed to have engaged in systematic problem-solving in the past, but he needed help to describe how or where. The student's answer to the problem-posing scenario is shown in Figure 6.

Researcher: Have you ever presented this kind of problem before? Can you elaborate?

D1: I did, yes. I was in sixth grade. As I do not remember much, I am unable to explain.

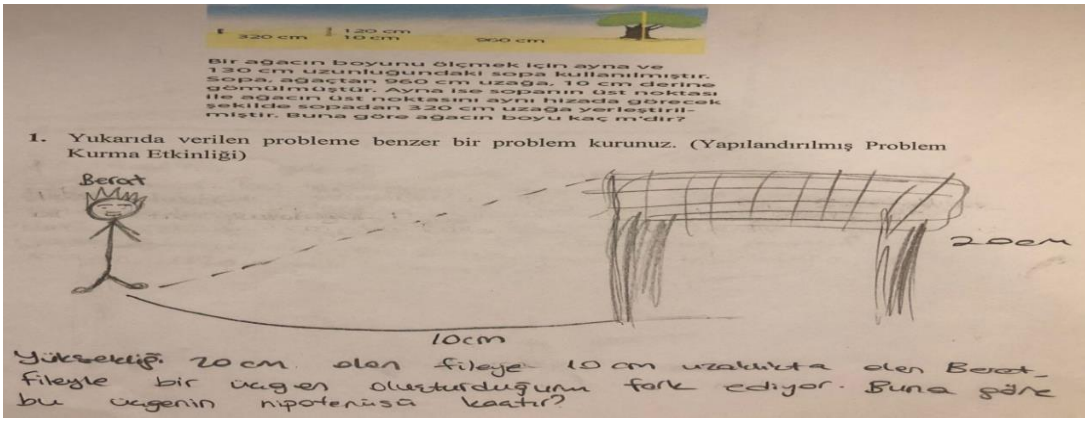


Figure 4. Student D_1's Response to Structured Problem Posing (first situation)

Examining the response of the student identified as D1 to the structured problem-posing situation shown in Figure 4 revealed that the student was unable to pose a problem appropriate for the scenario described in the instruction. The following summarizes the student's interview responses to the problem situation.

Researcher: Could you explain what you did step by step when a problem pose?

D1: I created my problem to resemble the query you posed. I needed to figure out how far Berat was from the volleyball net. Angle served as my subject. I sought to employ similarities.

Researcher: Is the problem you presented similar to others?

D1: I attempted to make the distance between the edges appear like the problem, but it did not seem like something other than it.

In that situation, the participant tried to explain his problem-solving process.

Students with the names D1, D2, D3, O1, O2, O3, and O3 had trouble posing the problem, whereas students with the names D1, D3, O1, and O2 struggled to come up with a story or work of fiction when posing the problem.

- **Structured problem posing situation 2:** Students were required to develop a situation in which to apply the guidance below. The pupils were instructed to build a geometry problem with a proportional condition and asked to memorize the topic of "Slope" to complete the assignment. Figure 5 depicts the structured second problem-posing situation.


2.

$\frac{1}{20}$

Tüm ticari binaların ve kamu binalarının en az bir girişindeki eğimler, engelli veya tekerlekli sandalye kullanıcıları ile bastonlu kişilerin rahat ve güvenli geçişini sağlayacak şekilde yapılmalıdır. Bunun için girişler, basamaksız olarak en fazla %5 eğimli olacak şekilde düzenlenmelidir. %5 eğim olması rampanın yerden yüksekliğinin, yere bitişik kenarının uzunluğuna oranının 1/20 olması demektir.

Siz de eğim tanımından yararlanarak ve yukarıda verilenleri dikkate alarak orantısal durum içeren bir geometri problemi kurunuz. (Yapılandırılmış Problem Kurma Etkinliği)

Figure 5. Second Structured Problem Posing Situation in PPT

All the students attempted to pose a problem and could describe the difficulty they had made, which was discovered after examining the answers. All students, except student Y3, attempted to complete a problem-posing exercise according to the instructions. Figure 6 shows the response provided by student Y3 to the problem-posing situation.

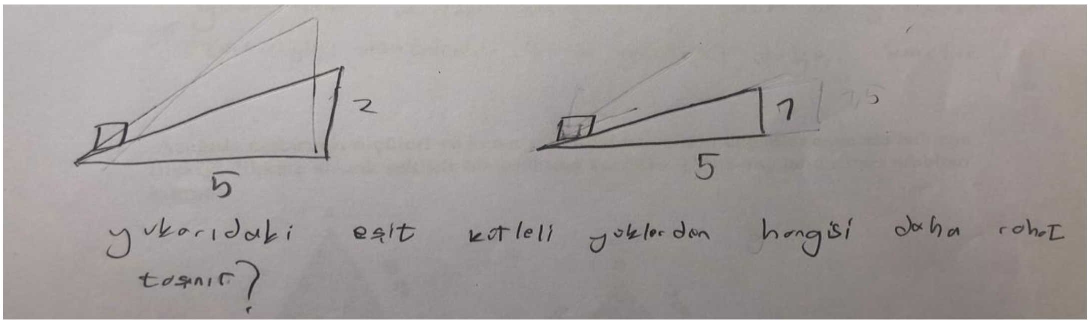


Figure 6. Student Y3's Response to the 2nd Structured Problem Posing Situation

However, in his reaction to the problem-posing situation shown in Figure 6, Y3 presented a problem unrelated to the instruction. While it was found that students D3, O1, and Y2 attempted to provide a problem that included the lesson as it is, it was noted that students D1, D2, O2, O3, and Y1 attempted to construct several issues that included the lesson. Students with the initials D1, D2, D3, and O2 modified the instruction but could not produce a problem. Figure 7 shows the solution provided by student O2 to the second structured problem situation.

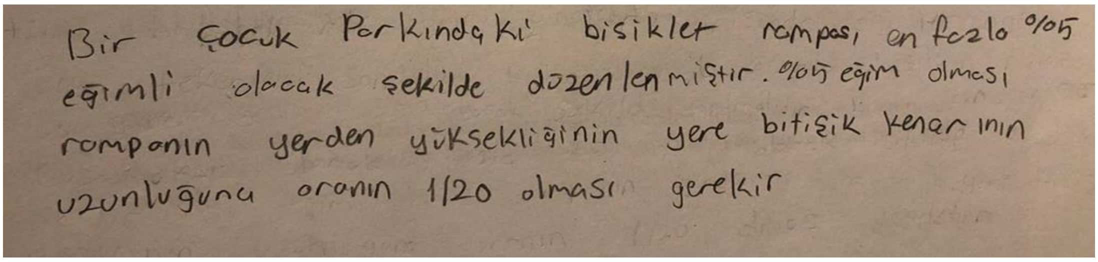

Bir çocuk Parkındaki bisiklet rampası, en fazla %5 eğimli olacak şekilde düzenlenmiştir. %5 eğim olması rampanın yerden yüksekliğinin yere bitişik kenarının uzunluğuna oranın 1/20 olması gerekir

Figure 7. Student O2's Response to Structured Problem Posing (second situation)

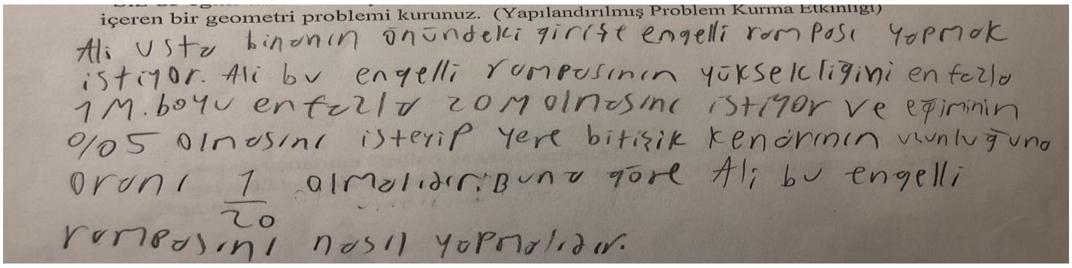
For the second structured problem situation shown in Figure 7, student O2 was unable to pose a problem in accordance with the desired instruction. These are the students' opinions on the problem-posing situation.

Researcher: Could you please spell out step-by-step what you did when a problem posed?

O2: I also modified the scenario in this question. I used the slope and ratio provided to us and did not alter them.

Participant used slope and ratio terms while posing a problem.

In Figure 8, the answer given by D3 to the second structured problem-posing situation is provided.



içeren bir geometri problemi kurunuz. (Yapılandırılmış Problem Kurma Etkinliği)

Ali usta binanın önündeki girişe engelli rampası yapmak istiyor. Ali bu engelli rampasının yüksekliğini en fazla 1 m. boyu en fazla 20 m olmasını istiyor ve eğiminin %05 olmasını isteyip yere bitişik kenarının uzunluğuna oranı 1/20 olmalıdır. Buna göre Ali bu engelli rampasını nasıl yapmalıdır.

Figure 8. Student D3's Response to Second Structured Problem Posing Type

For the second structured problem situation shown in Figure 8, the student identified as D3 could not pose a problem in line with the intended instruction. These are the student's opinions on the problem situation.

Researcher: Could you please spell out what you did when a problem occurred?

D3: I took the accessible ramp, inquired about the construction of the handicap ramp, provided the pertinent details, switched the positions of the integers, and sought to determine the height.

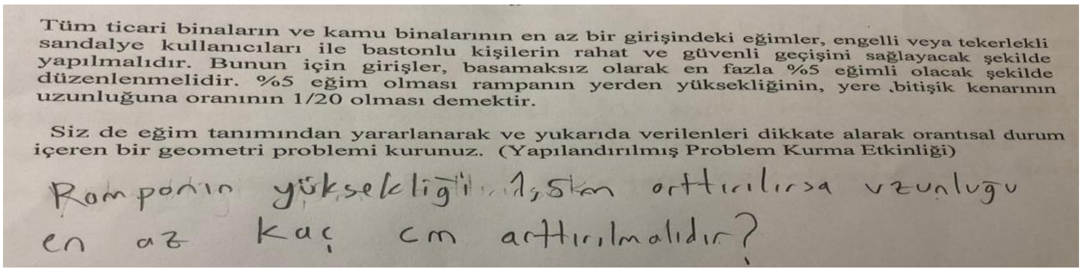
Researcher: Was the information provided accurate? Is it appropriate?

D3: I just checked, and that did not happen.

What would need to occur for it to be proportional, researcher?

D3: The numbers would continue to be expected, and it is essential to understand the proportional condition. Similar to its slope and length. Participants focused on the proportional condition.

The student identified as O1 and attempted to offer a problem using the guidance. Students D3, O1, O2, O3, Y1, Y2, and Y3 could understand the concept of slope by the instructions provided. However, D1 and D2 do not need help understanding why they should use the concept of slope. Only the students designated O3 and Y1 could formulate a geometry problem with proportional situations by the instruction, even though all students knew that they should employ the slope problem. Figure 9 depicts the problematic circumstances that students face.



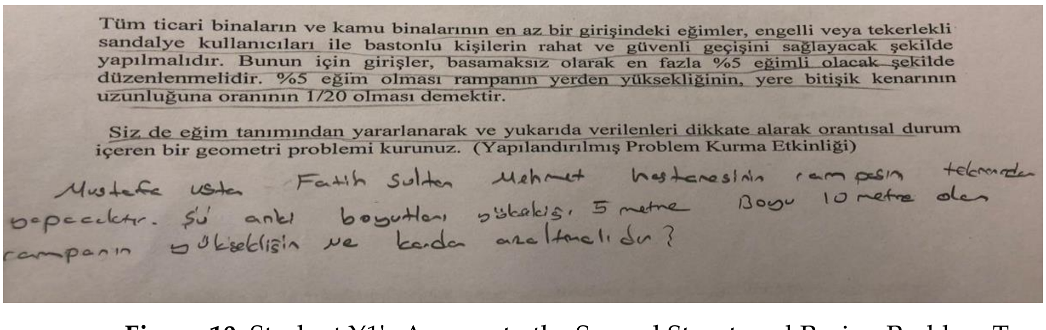
Tüm ticari binaların ve kamu binalarının en az bir girişindeki eğimler, engelli veya tekerlekli sandalye kullanıcıları ile bastonlu kişilerin rahat ve güvenli geçişini sağlayacak şekilde yapılmalıdır. Bunun için girişler, basamaksız olarak en fazla %5 eğimli olacak şekilde düzenlenmelidir. %5 eğim olması rampanın yerden yüksekliğinin, yere bitişik kenarının uzunluğuna oranının 1/20 olması demektir.

Siz de eğim tanımından yararlanarak ve yukarıda verilenleri dikkate alarak orantısal durum içeren bir geometri problemi kurunuz. (Yapılandırılmış Problem Kurma Etkinliği)

Rampanın yüksekliği 1,5 cm arttırılırsa uzunluğu en az kaç cm arttırılmalıdır?

Figure 9. Student Y2's Answer to the Second Structured Posing Problem Type

The problem in Figure 9 determined that student Y2 needed to provide numerical information and contain complete information. The problem situation created by the student named Y1 is given in Figure 10.



Tüm ticari binaların ve kamu binalarının en az bir girişindeki eğimler, engelli veya tekerlekli sandalye kullanıcıları ile bastonlu kişilerin rahat ve güvenli geçişini sağlayacak şekilde yapılmalıdır. Bunun için girişler, basamaksız olarak en fazla %5 eğimli olacak şekilde düzenlenmelidir. %5 eğim olması rampanın yerden yüksekliğinin, yere bitişik kenarının uzunluğuna oranının 1/20 olması demektir.

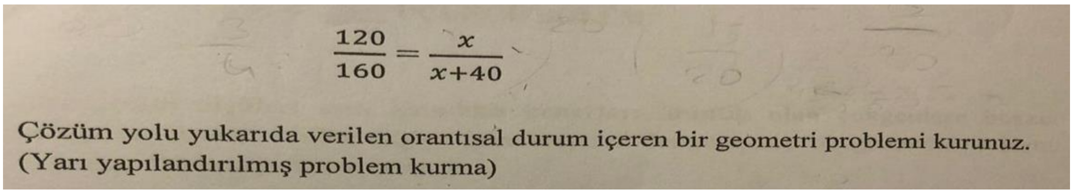
Siz de eğim tanımından yararlanarak ve yukarıda verilenleri dikkate alarak orantısal durum içeren bir geometri problemi kurunuz. (Yapılandırılmış Problem Kurma Etkinliği)

Mustafa usta Fatih Sultan Mehmet hastanesinin rampasını tekrardan yapacaktır. Şu anki boyutları yüksekliği 5 metre Boyu 10 metre olan rampanın yüksekliğini ne kadar azaltmalıdır?

Figure 10. Student Y1's Answer to the Second Structured Posing Problem Type

It has been established that the problem situation that the student identified as Y1 has created in Figure 10 is the desired kind of difficulty as instructed. During the interviews with the students, it was discovered that they still needed to complete a problem-posing exercise based on the guidance provided regarding the sort of organized problem. Students D2, O1, O2, O3, and Y1 had trouble generating problems that followed the instructions. At the same time, D2 and O1 struggled to write fiction for their difficulties, and O2 had trouble setting the numerical data but also had the fiction for the problem. O2 also needed help constructing the problem's fiction.

- **Semi-structured problem posing situation 1:** The students were given a task as the first problem-posing situation in the semi-structured problem type, and they were expected to construct a proportional geometry problem that included triangles, parity in triangles, similarity, and slope in triangles, which are mainly included in the eighth-grade mathematics course achievements. Figure 11 depicts the semi-structured first problem-posing situation.



$$\frac{120}{160} = \frac{x}{x+40}$$

Çözüm yolu yukarıda verilen orantısal durum içeren bir geometri problemi kurunuz.
(Yarı yapılandırılmış problem kurma)

Figure 11. First Semi-Structured Problem Posing Situation in PPT

The first problem-posing situation was semi-structured, as shown in Figure 11, and the students were expected to pose a problem in line with the guidance provided for the solution. The pupils D1, D2, and D3 did not respond to the question from semi-structured problem 1 when the difficulties presented by the students were assessed. When asked why they chose not to respond during the interview, students D1, D2, and D3 responded that the offered technique made no inferences.

Researcher: Could you explain why you chose not to respond to the problem-posing situation?

D1: I could not pose a dilemma because, at that time, nothing occurred to me.

Researcher: Do you have any thoughts on the described transaction when you reflect on it?

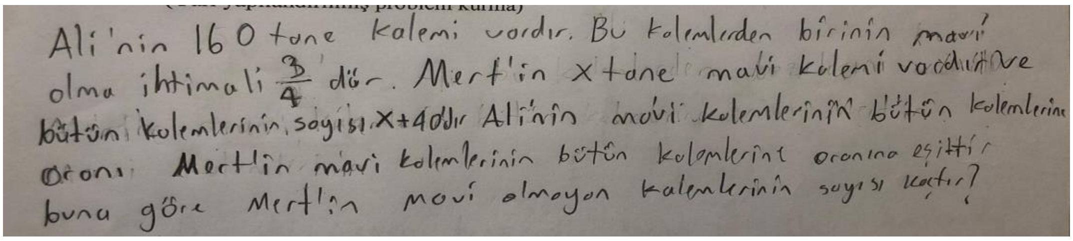
D1: It does not; I am unable to.

D2: I did not comprehend the question that was asked. I was at a loss for what to do.

D3: I could not think of anything. I could not understand the action.

Figure 12 shows the Y2 student's answer to the semi-structured first problem-posing situation.

Participants D1, D2, and D3 did not pose problems requiring proportional reasoning.



Ali'nin 160 tane kalemi vardır. Bu kalemlerden birinin mavi olma ihtimali $\frac{3}{4}$ dür. Mert'in x tane mavi kalemi vardır ve bütün kalemlerinin sayısı x+40dır. Ali'nin mavi kalemlerinin bütün kalemlerine oranı Mert'in mavi kalemlerinin bütün kalemlerine oranına eşittir. buna göre Mert'in mavi olmayan kalemlerinin sayısı kaçtır?

Figure 12. Y2 Student's Response to the Semi-Structured 1st Problem Posing Situation

It was discovered that, among the students who responded to the problem, only student Y2 had conducted problem-posing research with a different conclusion unrelated to the geometry shown in Figure 12.

The difficulties produced by students other than Y1 were mainly related to similarity, although they needed more information in terms of subject material. It was found that students O1, O2, O3, Y1, and Y3 sought to apply the instruction given in the problem they made. When examining the response provided by the student identified as O2 to the semi-structured problem presented below, it was noted that the student associated the similarity issue with the supplied operation but omitted to mention the parallelism between the BC and DE edges. Figure 13 shows the student's answer to the semi-structured first problem-posing situation.

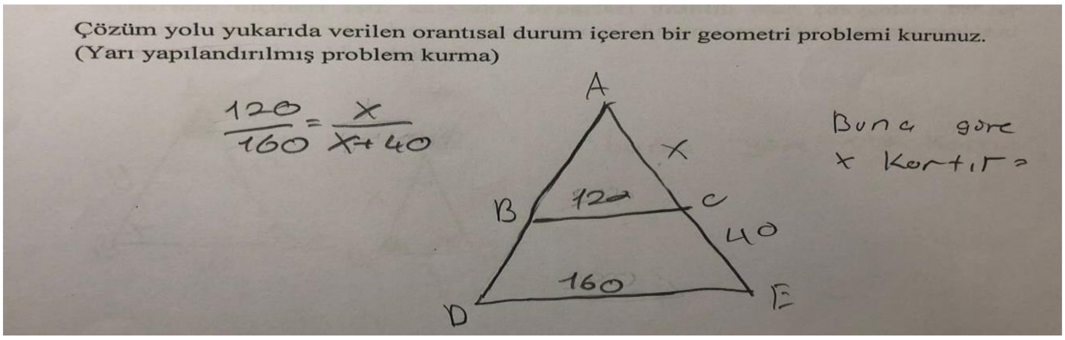


Figure 13. O2 Student's Response to the Semi-Structured 1st Problem Posing Situation

On the other hand, student O2 attempted to use the guidance in his problem, but he had insufficient knowledge regarding parity and likeness in triangles, and his study was more of an exercise than a problem. Figure 14 shows the response provided by the O3 student to the semi-structured first problem-posing situation.

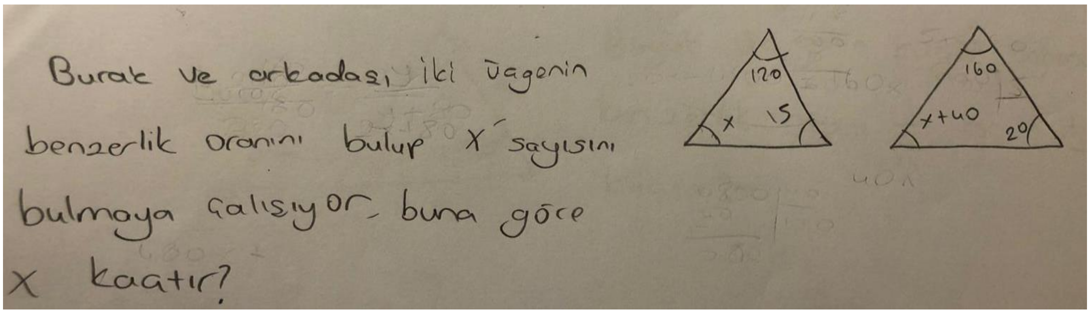


Figure 14. O3 Student's Response to the Semi-Structured 1st Problem Posing Situation

It is evident that student O2 is trying to apply the lesson to his problem, but there needs to be more understanding regarding the concepts of parity and similarity in triangles. He also tries to prove that the angle measures in a triangle are comparable. Figure 15 depicts the solution provided by student Y1 to the semi-structured first problem-posing situation.

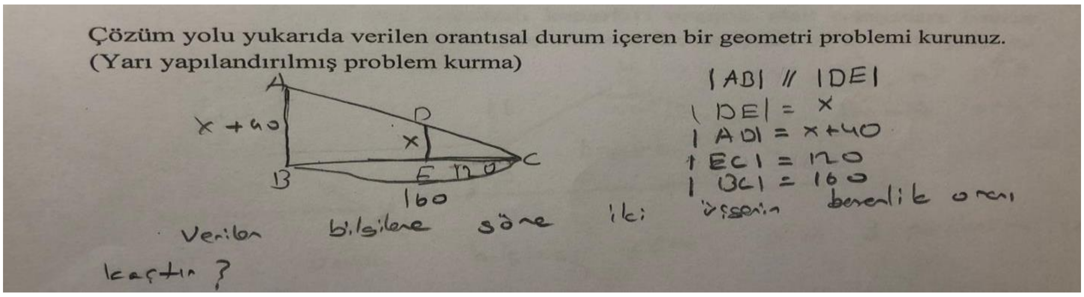


Figure 15: Y1 Student's Response to the Semi-Structured 1st Problem Posing Situation

Examining the response provided by the student identified as Y1 to the semi-structured first problem-posing situation in Figure 15, it was found that the student successfully used the provided instruction to build a problem of the desired sort.

Students who employed the instruction for the semi-structured first problem-posing situation were found to attempt to use the similarity subject more frequently than they did the slope subject. In an interview with the children, they revealed that the O2 student had developed a semi-structured problem in elementary school, and the student had done the same in a different educational setting. Some students claimed they had never conducted a study on such an issue. Students D1, D2, D3, and Y2 reported having problems with the semi-structured first problem-posing scenario. D3 reported having problems modifying the fiction and numerical facts, and Y2 reported problems developing the fiction.

Researcher: Was it challenging for you to pose the problem? What did you find the most difficult? Can you elaborate?

D3: I was made to. I was unsure of how to phrase the query. Through this procedure, I was unable to find what I was looking for, and now I'm unable to repeat it.

Figure 16 depicts the solution provided by student Y3 to the semi-structured first problem-posing situation.

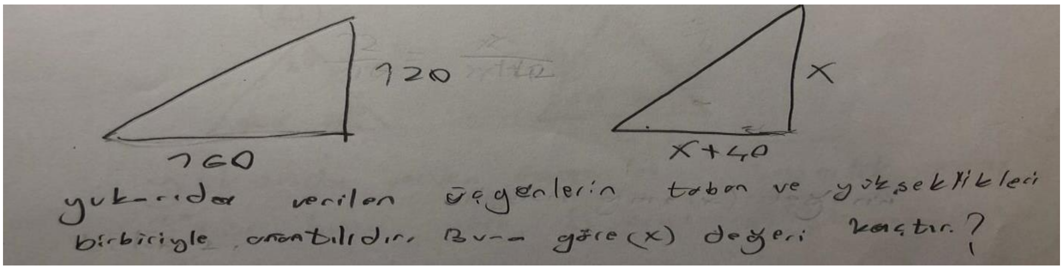


Figure 16. Y3 Student's Response to the Semi-Structured 1st Problem Posing Situation

Only three pupils—O2, Y1, and Y3—whose problem-posing status is shown in Figure 16—could present geometry problems with proportional conditions out of all the students.

- **Semi-structured problem-posing situation 2:** The students were given two alternative triangles with congruent interior angles and proportional sides opposing the equilateral angles as the second problem-posing situation in the semi-structured problem type. The students were asked to design a proportional geometry problem that covered the eighth-grade mathematics topics of "Triangles," "Consistency and Similarity in Triangles," by figuring out how the given triangles related to one another. They were asked to establish a relationship between two triangles' angles and side lengths. Figure 17 provides the desired instruction regarding the problem-posing situation.

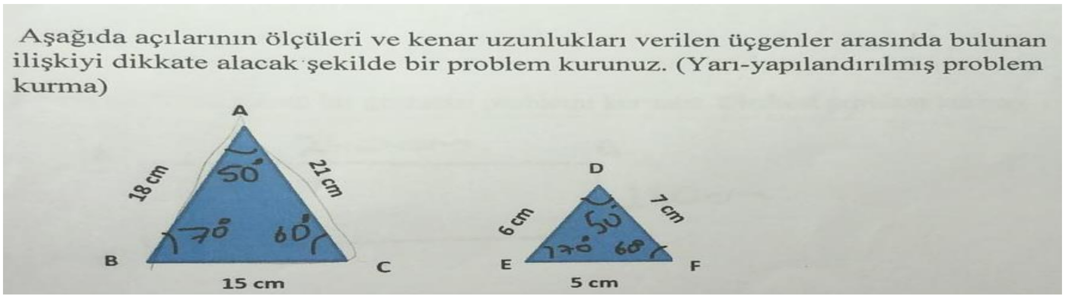


Figure 17. Second Semi-Structured Problem Posing Situation in PPT

Figure 17 determined the desired problem type, and the students were asked to pose a problem considering the proportional relationship in the given figures.

Here are the findings from the student interviews and their responses to the second semi-structured problem-posing situation in the problem-posing test and the interviews. It was found that every student responded to the semi-structured problem-posing situation, could explain how they came up with their problems and could apply the lesson. Students with the names D1, D2, O1, O2, O3, Y1, Y2, and Y3 were able to pose a problem in line with the instruction, whereas students with the names D2, D3, O3, and Y1 were unable to do so. Figure 18 depicts the solution provided by student D2 to the semi-structured second problem-posing situation.

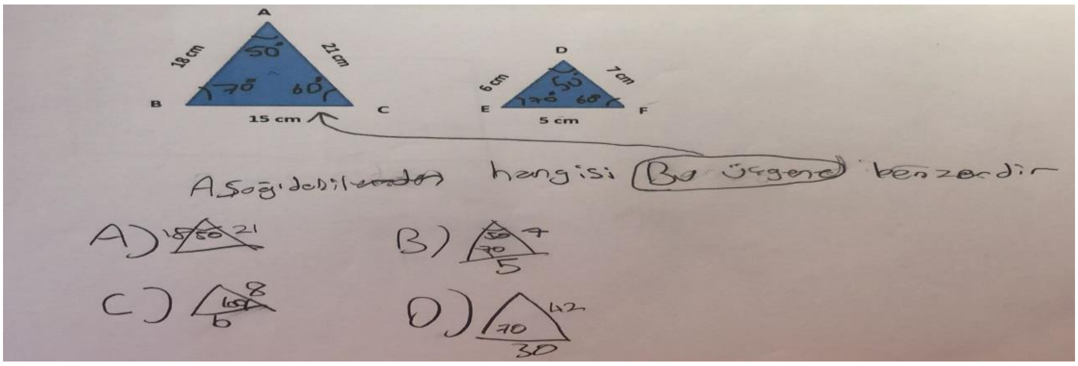


Figure 18. D2 Student's Response to Second Semi-Structured Problem Posing Situation

As seen in Figure 19, the student identified as D2 was unable to follow the instructions correctly. He was supposed to use the information provided to create an open-ended problem, but it was found that the student only created a multiple-choice problem while noting the similarities between the triangles.

Researcher: Could you explain what you did when a problem was posed?

D2: I stated that it is comparable to the triangle above and provided options. It is similar to this triangle. The choice I made that was closest to this triangle's value was the correct one. These two triangles have a fold relationship to one another—comparable triangles.

Participants focused on similarity in triangles.

The response to the semi-structured second issue posing scenario provided by student D3 is shown in Figure 19.

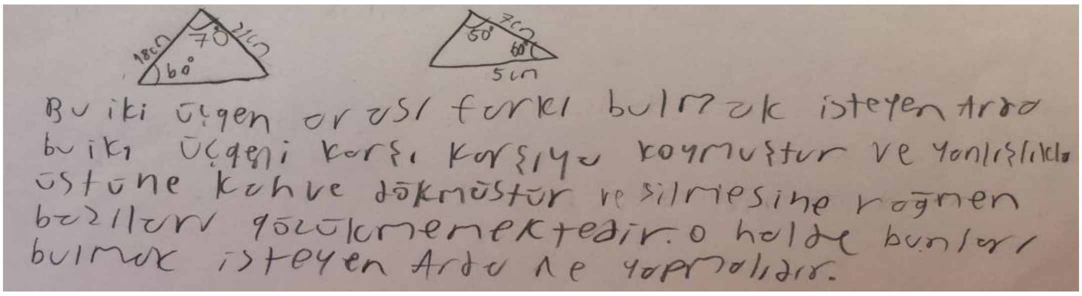


Figure 19. D3 Student's Response to the Semi-Structured 2nd Problem Posing Situation

In Figure 19, the student named D3 could not realize the subject of "Similarity and Similarity in Triangle," which is expected to be noticed in the case of posing a semi-structured second problem, and could not create the necessary conditions for using the subject "Similarity." The answers given by the students during the interview are written below.

Researcher: Could you explain step by step what you did in case of problem posing?

D3: I used the given numbers but left one side blank. I wanted to find out how many sides there are in both. I did not see the relationship between them.

Participant posed a problem by making a comparison between two triangles.

Figure 20 shows the response of the student named O1 to the semi-structured second problem-posing situation in PPT.

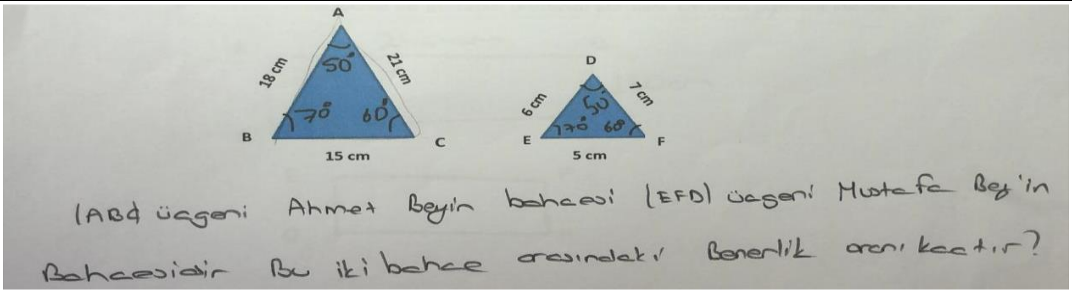


Figure 20. O1 Student's Response to the Second Semi-Structured Problem Posing Situation

According to the intended instruction, it has been established that the problem situation of the student designated O1, whose problem-posing state is shown in Figure 20, is a geometry problem with a proportionate situation. Below is a description of the justification offered by student O1 during the interview.

Researcher: Could you detail what you did step by step when a problem was posed?

O1: I immediately got it. Here, I focused on the direct angle's length. For him, I constructed a garden. I asked, "What is the similarity ratio between Ahmet and Mustafa Bey's gardens in the ABC triangle? Everybody had a 1/3 ratio.

Only O1, Y2, and Y3 students could use the instruction to solve a geometry problem with proportional situations. Students named D1, D2, O1, O3, Y1, Y2, and Y3 noticed "Similarity and Similarity in Triangle," which is expected to be noticed in the instruction while creating the problem. It was decided how the problem was created. It has been found that all of the students have yet to engage in a problem-posing scenario like the semi-structured second problem-posing situation.

When a structured second problem was presented, students D1, D3, and O2 rated the difficulties challenging. The student opinions are also included below.

Researcher: Was it challenging for you to set up the problem? What did you find the most difficult? Can you elaborate?

O2: I was made to. Writing the side lengths proved challenging. Also, I initially needed help to entirely modify the internal angles. I focused on the edges where the internal angles faced. I discovered a straight line between internal angles and sides.

O3: I was not made to. I recalled the topic as I observed the procedure.

Y1: I was not coerced, no. I was satisfied with what was provided. I did not feel pressured to find similarities. I have already figured out several similar problems.

- ***Free problem posing situation 1:*** The final component of the problem test required the students to present a free-form problem. Figure 21 shows the appropriate instruction for the intended free problem-presenting situation.

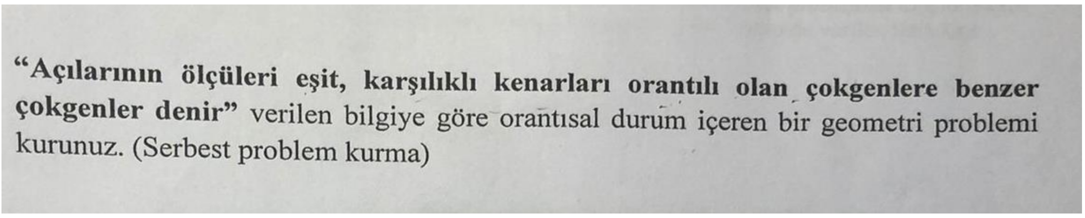

"Açılarının ölçüleri eşit, karşılıklı kenarları orantılı olan çokgenlere benzer çokgenler denir" verilen bilgiye göre orantısal durum içeren bir geometri problemi kurunuz. (Serbest problem kurma)

Figure 21. First Free Problem Posing Situation in PPT

The instructions for free-type problem 1 in Figure 21 explicitly defined similarity, and the students were asked to base their creation of a geometry problem with a proportional situation on this definition.

It was observed that all students, except D1, responded to the free-type problem and attempted to explain the difficulty they were trying to construct when the student's comments about the first problem were asked in the semi-structured interview form. This is the response provided to the problem-posing situation by student D1.

Researcher: Can you explain why you could not construct a problem for the free type 1 problem-posing?

D1: I was unable to produce. When I read it, I did not get it. I am not capable of doing this. I fail to see the similarities. I am varying it.

Participant D1 did not pose a problem related to the first free problem-posing situation. He believed that he could not pose such a problem.

Figure 22 shows the response provided by a student named D3 to the first problem-posing situation in the free type.

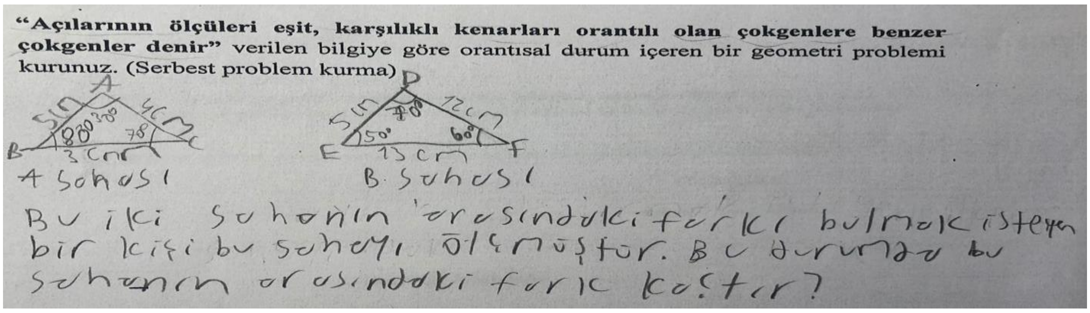


Figure 22. D3 Student's Response to the 1st Free Type Problem Posing Situation

The D3 student needed help using the guidance in Figure 22 to produce the appropriate problem. The following provides the answers to the interview questions.

Researcher: Could you detail what you did step by step when a problem was posed?

D3: I provided A and B as two fields. What distinguishes these two fields—one larger than the other?—from one another?

It was found that only the students called O2, O3, Y1, Y2, and Y3 constructed difficulties by the instruction, even though all of the other students—those who were supposed to pose a free-type problem—used the given instruction. Figure 23 shows the response provided by student Y1 to the first problem-posing situation in the free type.

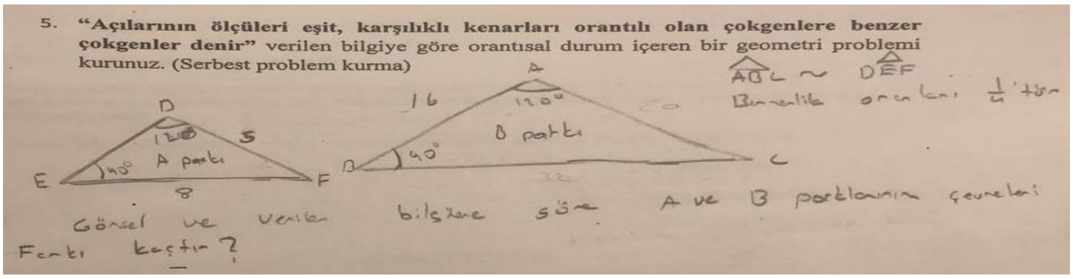


Figure 23. Y1 Student's Response to the 1st Problem Posing in Free Type

It was found that student Y1, whose response is shown in Figure 23, used the instruction and followed it exactly when creating a free-type problem.

Researcher: Could you detail what you did step by step when a problem was posed?

Y1: In these situations, I also used similarity. After providing specific angles, I again questioned the difference in the perimeters of two comparable triangles.

Researcher: Did you depart from the outline I provided?

Y1: Yes.

Participant Y1 used similarity and the difference in the perimeters of two comparable triangles after providing specific angles.

When the student O1's first problem-posing situation, shown in Figure 24, is investigated, it becomes clear that the student is attempting to construct a problem unconnected to the given instruction and has a different outcome.

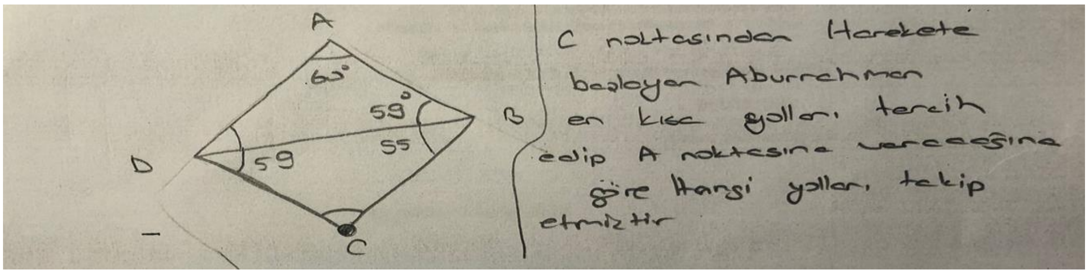


Figure 24. O1 Student's Response to the 1st Free Type Problem Posing Situation

The student identified as O1 in Figure 24 remained silent when asked whether he had ever utilized the subject of similarity and whether it needed to be brought up during the interview instruction.

Researcher: Could you detail what you did step by step when a problem was posed?

O1: As the side directly across from the angle is small, I was looking for the shortest side.

Researcher: Do you think this problem has a geometric and proportional problem?

O1: Although it involved geometry, the situation was not proportionate.

All of the students, with the exception of student O1, were found to have detected a similar topic in the offered instruction. The students D2, O2, O3, Y1, Y2, and Y3 applied a similar subject to the problem they tried to develop. Despite the fact that student D2 was aware of the similarities issue, his lack of topic understanding prevented him from being a problem. It was found that all the pupils had yet to gain prior experience with open-ended problems.

Researcher: Was it challenging for you to pose the problem? What did you find the most difficult? Can you elaborate?

D1: I did indeed struggle. It pressed me because I could not apply the similarities to the problem.

D3: Once more, I had no idea how to phrase my inquiry or what to inquire about. Despite the definitions, I could not compare them since I needed to grasp their similarities.

Y1: I was compelled to change the side lengths to make them equal. Other than difficulty changing the proportion, everything went smoothly.

Students D1 and D3 reported having trouble editing and changing numerical data while posing problems in the free problem style, while Y1 reported having trouble arranging solely numerical data. The students who claimed that creating a problem was not difficult for them said this was because the similarities problem was apparent.

O3: He did not push it, no. Knowing what similarity means helped me to understand it better.

Y1: I was not coerced, no. I knew what to do, so it was not a problem.

Only O2 and O3 were able to formulate a geometry problem using proportional circumstances among the pupils. Students who attempt to suggest difficulties tend to produce more examples in the exercise-style assignments. Figure 25 shows the response of student Y3, who serves as an illustration of this circumstance.

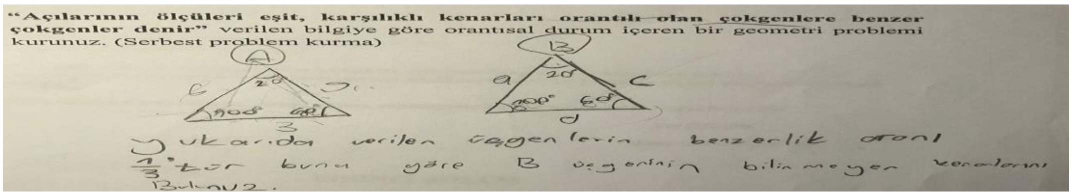


Figure 25. Y3 Student's Response to the 1st Free Type Problem Posing Situation

When the problem that student Y3 posed in Figure 25 was examined, it became clear that the student had conceptual weaknesses, was unable to adequately explain the similarity ratio between the triangles while writing the similarity ratio, and had instead created more of an exercise rather than using the concept of similarity in the problem's instruction.

Free problem posing situation 2: For the last problem in the third part, the students were asked to produce a free problem posing type problem, as given in Figure 26.

Orantısal durum içeren bir geometri problemi kurunuz. (Serbest problem kurma)

Figure 26. Second Free Problem Posing Situation in PPT

In the free problem shown in Figure 26, students were asked to construct a simple problem with proportional scenarios without providing any examples or information to support their answers.

All students, with the exception of D2 and D3, responded to the free-form problem posed in the semi-structured interview and were able to explain their responses.

Researcher: Could you clarify step by step what you did in case of problem posing?

D2: Nothing occurred to my thoughts, no questions. I could not do it.

D3: I needed to grasp the problem. I couldn't, I became bored, I didn't want to cope with it.

It was seen that the pupils called O1, O2, O3, Y1, Y2, and Y3 sought to produce problems by following the intended instruction in the problems they tried to generate. Student D1 wrote a proportional operation but needed help to develop a problem that would work with it. The difficulty provided by the student is shown in Figure 27.

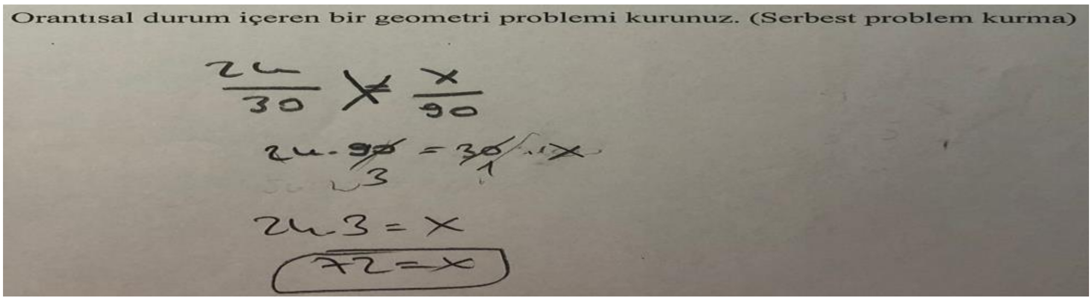


Figure 27. D1 Student's Response to the 2nd Free Type Problem Posing Situation

When student D1's response to the second problem-posing scenario in the free type was considered, it became clear that the student was unable to pose a problem and had instead discovered an answer for the method he was required to employ. The following is the answer given by the D1 student during the interview.

Researcher: Could you clarify step by step what you did in case you had difficulty posing?

D1: There is no problem; I wrote a transaction. I wanted to follow the procedure for mirroring, but I didn't know what to do, so I could not cause a problem. I cannot do that again now.

Again, pupils called O1, O2, O3, Y1, Y2, and Y3 sought to pose a problem in line with the instruction. The same students applied the "Association and Similarity" concept to the problems they were trying to generate. The response of the student named O1 is given in Figure 28, while the answer of the student named Y2 is shown in Figure 29.

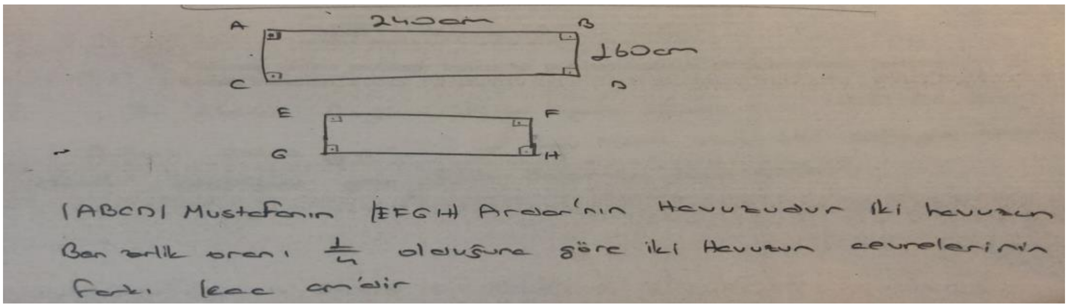


Figure 28. O1 Student's Response to the 2nd Free Type Problem Posing Situation

When the answer provided by student O1 to the second problem-posing situation shown in Figure 28 was examined, it was discovered that the student's problem was appropriate for the desired problem type, included achieving the geometry learning field for an eighth-grade math lesson, and involved proportional situations.

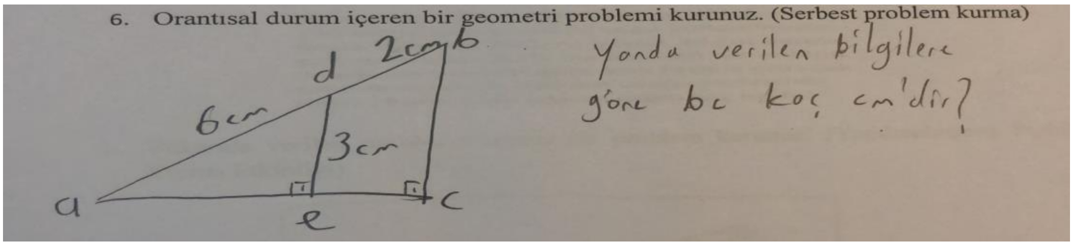


Figure 29. Y2 Student's Response to the 2nd Free Type Problem Posing Situation

When the response provided by student Y2 to the second free-type problem posing situation shown in Figure 29 was examined, it was found that the student's problem was appropriate for the desired problem type, that it included achieving the geometry learning field for the eighth-grade mathematics lesson, and that it was a proportional situations exercise.

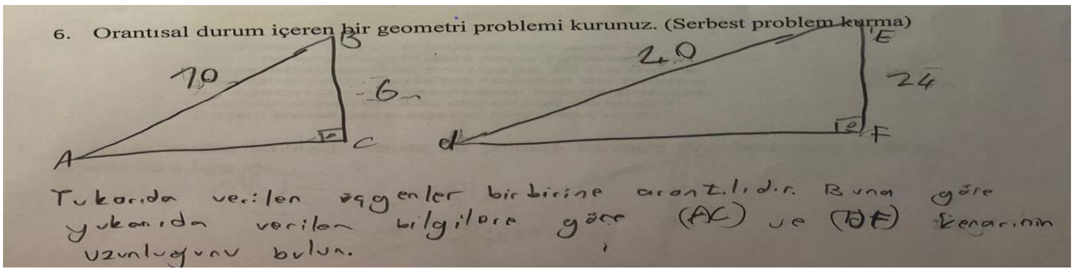


Figure 30. Y3 Student's Response to the 2nd Free Type Problem Posing Situation

Examining the response provided by student Y3 to the second problem-posing situation in the free type reveals that the situation was constructed as an exercise and involved many acquisitions.

Researcher: Could you please describe what you did when a problem occurred?

Y3: I benefited from the similarity. I added length to both triangles since I desired the other side.

Researcher: Do you think we can determine the base length of these triangles, which both lack one?

Y3: I am still trying to figure this out, yes. I then fail to locate the edge. I made a mistake.

Researcher: Should we attempt a different approach, researcher?

Y3: The "Pythagorean Theorem" can be used, yes.

Participant Y3 stated that Pythagorean Theorem can be used to solve that problem.

Apart from O3, no other student claimed to have had prior experience with open-ended problem-posing. O3 claimed that he practiced free problem-posing in school but needed help remembering the class or the time. D1, D2, D3, and O3 acknowledged that they found the supplied free problem posing kind of challenging. While D2, D3, and Y1 said they had trouble posing the task, D1, D2, D3, and Y3 said they had trouble altering the numerical data.

Researcher: Did you find it challenging to frame the problem, researcher? What did you find the most difficult? Can you elaborate?

D1: I still can't repeat it. I struggled because I didn't comprehend the subject or the statistics, and they didn't immediately spring to mind.

D2: Naturally, I struggled with this question and had no ideas.

D3: At that point, I was at a loss for words. I was compelled to do it; I could not and never thought to.

Students O3 especially mentioned that they had no problems using this problematic product and felt more at ease than the other students.

Researcher: Did you find it challenging to frame the problem, researcher? What did you find the most difficult? Can you elaborate?

Y3: Finding a topic was challenging, but the free problem was more convenient. It was not too difficult.

O3: He did not push it, no.

Researcher: Did you find the lack of an example question and the fact that it is of little value in comparison to other kinds of issues challenging?

O3: No, I believe it was more cozy. I find it easier to generate problems when the subject is unrestricted.

Only students O1, Y1, and Y2 were found to be able to formulate a proportional geometry problem of the free problem-posing kind appropriate for the second problem-posing scenario. The problem raised by student Y1 is used as an example in Figure 31.

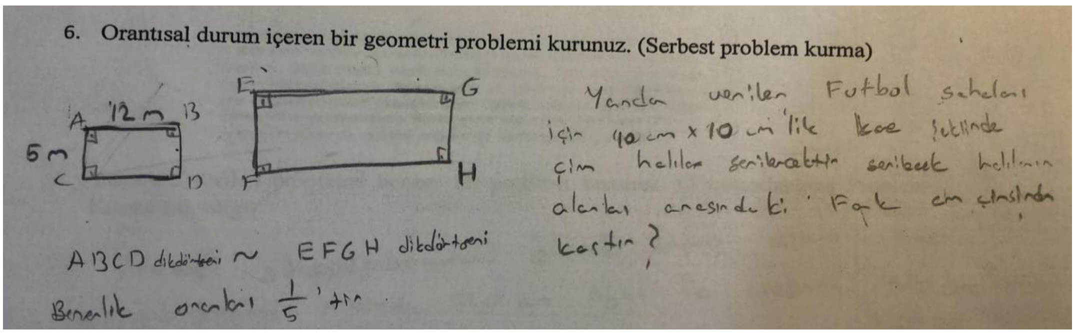


Figure 31. Student Y1's Response to the 2nd Problem Posing in Free Type

When the response provided by student Y1 to the second problem-posing situation in the free type shown in Figure 31 is examined, it is discovered that the student's problem fits the desired problem type, contains gains from the geometry learning field from an eighth-grade math lesson, and contains proportional situations.

DISCUSSION AND CONCLUSION

This study aimed to determine the performance of students who learn proportional reasoning in the classroom while posing geometry problems involving proportional situations, as well as the obstacles they encounter when posing problems. This section presents the outcomes acquired based on the research findings and the debates and recommendations generated as a result. When the literature studies are looked at, it becomes clear that teachers and researchers, in particular, have come to many conclusions about the academic and cognitive abilities of students through problem-posing studies (Çelik & Yetkin-Özdemir; 2011; Kar, 2014; Kılıç, 2013; Silver & Cai, 1996) and according to Özgen and Bayram (2019) and Özgen, Aydın, Geçici and Bayram (2017) noted that while studies are often related to a particular attitude, a subject (such as in the study of Çelik (2010) or a concept, such as in the study of Türnüklü (2017), or both, the relationship between various subjects or concepts.

This study, which looked at geometry problems pupils had posed and used proportional situations, was prepared as a result. The students' responses to proportional reasoning-based geometry questions and the method used to pose the problems and the issues they faced were examined. Eighth-grade secondary school students were chosen for the study because they were deemed to possess more excellent proportional thinking (Toluk- Uçar & Bozkuş, 2016). According to Şengül-Akdemir and Türnüklü (2017), the difficulties posed by students vary with their level of success, and pupils with high levels of accomplishment have little trouble while posing problems. Students with a high average score on the problem-posing test could perform more problem-posing exercises to the desired instructions.

In contrast, students with a low average score on the problem-posing test could pose fewer problems with the instructions. Even if students prepare for LGS from national exams and solve many questions, they need help posing problems, whereas students with a high success rate can do so. 62% of the problems presented by the students were geometry problems involving proportional circumstances; 24% of these problems were graded as "correct," 29% as "somewhat accurate," and 9% as "incorrect." Compared to students with medium and high scores on the problem-posing test, students with low scores on the problem-posing test could not relate the subject of geometry with proportional circumstances. They could not provide an example of this. It was observed that students who associated proportional situations with geometry primarily gave answers about similarity; they could not make associations between slope and other geometry topics, and students who scored higher on the problem-posing test primarily engaged in problem-posing activities pertaining to the slope. Çelenli, Taşpınar-Şener & Aydoğdu (2022) noted that fifty percent of the slope questions in their study demand proportional reasoning; therefore, it is possible that students' proportional thinking centered on the subject of the slope.

When the study's results were analyzed, it was revealed that not all students had previously performed and encountered structured, semi-structured, and free problem-posing (Stoyanova & Ellerton, 1996; Kılıç,2013). It was established that the problem type containing the most proportional cases was the free problem type and that an equal number of structured and semi-structured problems were formed. According to interviews with students with varying levels of success, it was determined that the students could not generate unique problems based on the instructions provided in the structured problem type. In the study conducted by Gökkurt and Örnek 2015), students attempted to generate the same or similar problems by altering the problem's name and numerical information. Although the students understood the similarity and slope problems addressed in organized questions, they struggled to formulate proportional problems. It was noted that while they provided more responses to the challenge requiring similarity study in organized difficulties, they struggled to create a proportional slope problem. It was determined that the student's problem circumstances included unrealistically inflated findings and that they ignored units and measures while generating proportions. When students' semi-structured problem-posing situations were evaluated, it was found that they predominantly used the similarity subject. However, there were misconceptions in posing proportional reasoning-required geometry problems. It was concluded that the pupils' geometry problem provided a multiple-choice or exercise-style question. Several research in the literature confirmed that the status of students' geometry problem posing differed in favor of students with high problem-posing exam scores (Geçici & Aydın, 2019; Şengül-Akdemir & Türnüklü, 2017).

Considering the free problem situations and opinions with which students produce the most problems, the idea that students feel more at ease when creating problems is the most prevalent. In both instructions, it was determined that those who were successful in posing problems among the students who understood the similarity problem created elementary problems, could not relate to daily life, used similarity in their problems, but had difficulty establishing a proportion in terms of similarity, particularly, as stated by Özgen et al. (2017), in adjusting numerical data. It was concluded that the pupils comprehended the material but struggled with the proportional relationship.

In the study conducted by Çelik (2010), in which students had difficulties posing questions involving proportionate situations, it was determined that students lacked proportional thinking skills and could not offer problems involving proportional situations. An effort was made to improve pupils' understanding of proportional and nonproportional circumstances. It was noticed that the pupils could define ratios and proportions and explain their meanings using simple examples. According to Çetinkaya and Soybaş (2017), when it comes to proportional situations, students tend to recall simple linguistic difficulties they experience daily, and these problems are typical. It was decided that there were work, worker, tap, and shopping problems and that he could not provide a geometry-related example. It was determined that the students conflate geometry and area measuring.

Although the importance of problem posing both students and teachers (Cai & Leikin, 2020; Van Harpen & Presmeg, 2013), students' problem-posing abilities are lacking (Ada, Demir & Öztürk, 2020; Çetinkaya & Soybaş, 2017; Kılıç, 2013; Özgün & Bayram, 2019; Turhan-Türkkan, 2018). When students" problem-posing skills were analyzed according to different problem-posing situations, it was determined that most mathematics problems were posed in the "filtering" situation, and in the "free" problem-posing situation, students were able to pose very few mathematics problems (Ada, Demir & Öztürk, 2020). Turhan-Türkkan (2018) indicated that students were found to be successful in the most structured problem-posing type, at least in the semistructured problem-posing type. In contrast, it was found that students who remembered doing some work partially did not remember anything about the subject or the content. Çetinkaya and Soybaş (2017) stated that they had a misconception between problem posing and practice, had no knowledge of problem-posing types, and did not engage in free, structured, or semistructured problem-posing exercises. Most students claimed that they identified proportional instances in a problem even before applying and searched for such situations to solve them. Due to the interviews and problem-posing, some study participants claimed they became aware of the subject they did not grasp, particularly regarding similarities. The students claimed that they had a clearer understanding of the subject when they observed several problem-posing scenarios. The students who took part in the study admitted that they were wary of skill-based questions, but after attempting to set it up independently, they discovered that it was not as challenging as it appeared. Students who participated in the study claimed to understand better how proportional situations can arise in geometrical problems.

Suggestions

This section of the study contains recommendations for teachers and future research based on the outcomes of the findings derived from the research data and the material accessible in the literature.

Implications

Suggestions for Implementation

- Students can complete problem-posing exercises on various subjects utilizing structured, semi-structured, and free problem-posing kinds.

· Problem-posing exercises that call for proportional thinking can be arranged by tailoring them to particular learning objectives or themes.

Research Ideas for the Future

· Making students complete exercises in proportional reasoning beginning in seventh grade will prepare them to address geometry problems in eighth grade.

· Students' performances in problem-posing activities that require proportional reasoning can be evaluated by adapting them to different acquisitions or subjects.

· Students' performance in problem-posing activities requiring proportional reasoning can be evaluated by adapting them to different learning situations.

Limitations

The limitation of the research is the study group size.

Statements of Publication Ethics

Ethical approval for this study was obtained with the decision of Istanbul Medeniyet University Educational Sciences Ethics Committee dated 01.03.2021 and numbered 2021/03-07.

Researchers' Contribution Rate

The contribution rate of the first author is 70%, while the contribution rate of the second author is 30% in the manuscript.

Conflict of Interest

There is no conflict of interest.

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