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EFFECTIVENESS OF UTILIZING SCENARIO-BASED INSTRUCTION TO TEACH "FUNCTIONS" TO HIGH SCHOOL STUDENTS IN MATHEMATICS CLASSES

Research Article

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Abstract

The aim of this study was to investigate the effects of teaching the subject of "Functions", utilizing scenarios associated with everyday life, to high school students in terms of their academic achievements. The study was carried out with twenty 10th grade students at a high school in a district of Bartin, Turkey in the 2018–2019 school year. In the study, which was based on the Mixed Methods, a weak quasi-experimental design with one pre-test and post-test group, was employed. Function achievement test (FAT) and semi-structured student interview form (SSIF) were used as data collection tools. During the study, scenarios and activities with the examples of daily life related subject of functions were applied for a period of 8 weeks. In the research, the quantitative data were analyzed via the Wilcoxon Signed-Ranks Test, and the qualitative data were analyzed using the coding technique. As a result of the analyses, it was observed that there was a significant difference between the pre-test and post-test scores in favor of the post-test.

Keywords: function, high school students, use of scenarios, mathematics, achievement

1. Introduction

Mathematics in everyday life is considered to be a product of the efforts of human beings to understand nature (Olkun & Toluk-Uçar, 2007). It is possible to see mathematics in all areas of life (Hacısalihoğlu, Mirasyedioğlu, & Akpınar, 2004). The fact that mathematics is the core of all sciences and that it is needed in all areas of life makes mathematics education significant. Regular, understandable, and practicable mathematics education can be provided starting in primary school. Although the importance of mathematics education is known in Turkey and necessary regulations have been made in mathematics curriculums from time to time, the desired level of success has not yet been achieved. The prominent indicator of this fact is that our students have not shown the desired improvement in international exams such as the Trends in International Mathematics and Science Study [TIMSS] and Programme for International Student Assessment [PISA]. One of the most important reasons for this is that mathematics taught in schools has not been associated with everyday life (Çağırgan-Gülten, Ilgar, & Gülten, 2009; Karakoç & Alacacı, 2012, 2015). According to Karakoç and Alacacı (2015), the students have not performed well in international exams such as the TIMSS and PISA because they were not familiar with the questions related to everyday life. Çağırgan-Gülten et al. (2009) investigated high school students' opinions about their using mathematics subjects in everyday life; they found that the students did not have sufficient knowledge about the use of mathematics in everyday life. The vast majority of students expressed that everyday life examples were not taught during the lessons and that they believed that experiencing everyday life examples in mathematics lessons would contribute to their learning (Çağırgan-Gülten et al., 2009).

One of the standards of mathematics education recommended by the National Council of Teachers of Mathematics [NCTM] (2000) is associating mathematics with everyday life and using mathematics in this context. It was expressed that using real-life contexts in mathematics lessons increases students' motivational levels and gives them the ability to apply mathematics to their daily life (Gainsburg, 2008; Sorensen, 2006, as cited by Karakoç & Alacacı, 2012). It was emphasized that real-life examples being related to students' experiences and realistic is important for the quality of mathematics education (Van Den Heuvel-Panhuizen, 2003).

It is important to incorporate real-life problems in mathematics lessons based on the statement that "real-life problems are included" in learning outcomes of the current curriculum (MoNE, 2018). Özaltun-Çelik & Bukova-Güzel (2019) stated that mathematical learning activities including real-life situations revive students' mental activities and foster associations between concepts and symbols.

The foundation of the constructivist approach is to activate learning by doing and experiencing. How an individual learns and constructs knowledge in his mind is more important than what he knows. Scenario-based instruction is one of the constructivist teaching methods. In this method, scenarios in which real-life related problems are fictionalized initiate learning. Scenarios are designed to attract students' attention, to arouse their curiosity, and to be ill-structured. In addition, the main purpose of scenarios is to help students reach the desired learning goals within the process (Musal, Akalın, Kılıç, Esen, & Alıcı, 2002). In this process, it is essential to question students' learning processes by asking questions to trigger their higher order thinking skills (Delisle, 1997). This instruction is based on a thorough understanding which provides learner-centeredness and active learner participation; it motivates learners and fosters their problem-solving skills, and it is based on problem-solving (Major & Palmer, 2001). The NCTM (2000) described instruction on problem-solving as an effective way of teaching mathematics. In this process, students are first presented with a problem situation. They subject the problem to various processes and try to reach the desired result. Because there are multiple ways to solve a problem, students are encouraged to take part in active learning and cooperation. Scenarios, which are used as an educational tool and contain a problem situation, are planned as stories that embody various real or real-like problems that may attract students' attention, preoccupy them about these problems, prompt them to solve the problems, and equip them with the ability to achieve required learning outcomes (Cantürk-Günhan, 2006). The students' investigating, questioning, searching in groups, and exploring the problem situations designed with scenarios of ill-structured daily life problems would contribute to their learning of the topic (Hendry, Ryan, & Harris, 2003).

The constructivist approach has been adopted and implemented in education in Turkey since 2005. The concept of function was associated with other disciplines, and different usage and application areas were provided in the rearranged secondary education curriculum (MoNE, 2018). The concept of function is one of the building blocks used in almost all areas of mathematics, and it is quite important for explaining, understanding, and using mathematical expressions (Eisenberg, 1991). The importance of expressing rules and definitions regarding the concept of function, of showing functions with multiple representations, of establishing relationships among these representations, and of giving examples from different application areas was emphasized in the curriculum (MoNE, 2018). The purpose of relational thinking is not reaching a mathematical answer but showing mathematical expressions in different ways and using the main features of these expressions (Yavuz-Mumcu, 2018). Relational understanding and thinking foster conceptual understanding skills that emerge in the process of learning mathematics and help enrich images related to concepts in the mind (Hiebert & Lefevre, 1986; Van de Walle, Karp, & Williams, 2012).

According to Argün, Arıkan, Bulut, and Halıcıoğlu (2014), the concept of function is the core of mathematics. In other words, it is at the core of almost all areas of mathematics, and it is a unifying concept functioning as a scaffold in mathematics. The development of a proper understanding regarding the concept of function requires understanding the relationship network of the concept thoroughly. However, according to Eisenberg (1991), different representations used for the presentation of functions and the existence of many sub-concepts of this concept are among the basic factors making it difficult to understand. In real life, functions come up with matches. Hence, teaching functions ought to be started with real-life modeling and needs to be developed with the idea of matching (Argün et al., 2014). Although the concept of function has been described in various ways depending on its epistemological development, these descriptions reflect similar thoughts in content. However, there are some differences as well. The first of these is the fact that "there is a correlation between two variables; that is, there is a change in the dependent variable with the change in the independent variable," while the second is the thought of function constructed on the concept of set.

In today's modern mathematics books, the concept of function is defined as a special pattern making matches between the elements of two sets. Accordingly, the definition of function based on the concept of set is given as "Let *A* and *B* be two non-empty sets and *f* be a relation from *A* to *B*. If *f* relation matches each element in set *A* to just one element in set *B,* this relation is called a function from *A* to *B*." Another definition of a function is that it is a dynamic process that converts inputs to outputs (Bayazıt & Aksoy, 2013). It has been suggested that the most influential approach for teaching functions and graphs is "concept-oriented instruction." This is because the multiplicity of thoughts and representations related to the concept of functions and factors such as cognitive levels and previous experiences of student groups can make learning this concept difficult (Bayazıt & Aksoy, 2013). Gaining and improving conceptual knowledge depends on making associations between concepts (Hiebert & Lefevre, 1986). Teachers ought to provide students suitable learning environments and opportunities to facilitate their learning. Associating the concept of function with daily life situations can contribute to conceptual learning. When teaching the concept to students, simply giving them the definition of functions and solving sample problems within the discipline are not sufficient for learning the concept. It is necessary to study solutions of problems which necessitates thinking of functions in combination with other disciplines and daily life examples (Bayazıt & Aksoy, 2013). In the current study, prepared scenarios and activities associate the topic of functions and function graphs with students' daily lives.

There are several national and international studies on functions in the literature (Bayazıt & Aksoy, 2010; Özaltun-Çelik & Bukova-Güzel, 2019; Clement, 2001; Tekin, Konyalıoğlu, & Işık, 2009). The studies carried out at the secondary education level about this topic were mostly case studies aiming to identify students' perceptions and views about the concept of function (Özgen, Aygün, & Hanazay, 2017; Yavuz & Hangül, 2014). It has been stressed that students had difficulties and misconceptions about the ways functions were represented and the relationships between them (Karahasan, 2010; Uygur-Kabael, 2010). Similarly, students have difficulty in determining if the patterns given are functions and in switching between representations (Akkoç, 2006). Vinner (1992) stated that students had the misconception that "a function should be given as a unique rule, its graph must be constant, and a function must be one-to-one," and they generally thought that a function had to contain some algebraic formulas (as cited by Yağdıran, 2005).

Karataş and Güven (2003) expressed that high school students and preservice teachers were unable to relate between different representations of functions, and the students were not able to decide if the statements given were functions or not. Evangelidou, Spyrou, Elia, and Gagatsis (2004) mentioned in their study, which was about recognizing functions and giving examples from real life, that a great majority of the students used the expression “a function is one-to-one” while defining the concept of function. In these studies, it was revealed that the concept of function is difficult to understand for students from all levels, and that it is one of the subjects that can easily confuse students. In addition, it was suggested that one of the reasons that students have difficulty with functions is that the concept is abstract by nature depending on its epistemological structure (Bayazıt, 2010).

In Turkey, cluster mapping, sets of ordered pairs, graphs, and algebraic representations regarding the concept of function are contained in course books within the curriculum (MoNE, 2018). Upon finishing secondary education, students need to be able to use functions easily to define mathematical relations (NCTM, 2000). Some everyday life examples using functions and function graphs include input-output and factory-product relation, mechanical physics problems including speed, time and orbital problems, piecewise functions and practices, and grade calculations, etc. (Karakoç & Alacacı, 2015). Graphical representation of functions is not limited to mathematics knowledge and the topic of functions. According to Monk (2003), graphics are communication tools used for expressing knowledge in different forms and instructional tools used to contribute to students’ thorough understanding of the concepts (as cited by Tekin et al., 2009). Furthermore, graphics provide convenience and clarity for organizing, summarizing, interpreting, and presenting the data (Taşar, İngeç, & Güneş, 2006).

It is evident from the results of previous studies that it is necessary to be careful in the teaching of a subject that can easily mislead students and to relate the concept of functions to known concepts and to make concept-oriented lessons with examples from daily life. The research focused on the use of scenarios in teaching functions and graphics was not found in our literature search. The reason for choosing the topic of function and its graphics in the current study was that it is difficult for students to understand, and it is one of the subjects that can be misleading (Akkoç, 2006; Bayazit,2010; Bayazit & Aksoy, 2013; Evangelidou et al., 2004; Karataş & Güven, 2003; Vinner, 1992, as cited by Yağdıran, 2005). In addition, the topic of functions constitutes the basis for learning other topics as specified in the secondary education curriculum. It is proposed that instruction implemented by relating this concept to previously learned concepts and everyday life would facilitate learning. Therefore, in the current study, we investigated the impact of instruction using scenarios prepared by associating the topic of functions and function graphs with daily life on the mathematics achievement of 10^{th} graders. For these reasons, the current study contributes to the existing literature. In this study, the instruction was carried out by using problem situations (scenarios) and activities created from daily life related to the topic of functions and function graphs. The problem situations were presented by associating them with daily life, and answers to the following sub-problems were sought:

1) Does teaching implemented with scenarios on functions make a significant difference between the pretest and posttest scores of 10^{th} grade students?

2) What are the 10^{th} grade students’ response categories for the questions in the test on functions learned by instruction with scenarios?

3) What are the views of 10^{th} grade students regarding the method implemented while teaching the topic of functions?

2. Methodology

In this study, the Mixed Methods based on both quantitative and qualitative data was employed. According to Rossman and Wilson (1994), two methods supporting and confirming each other provides an opportunity for a detailed and developed analysis and correcting the deficiencies by synthesizing the two methods creates an opportunity for better reliability of the study. Two reasons for using the two methods together are complementarity and expansion. Quantitative and qualitative data are designed to complement each other as well as to expand the limits of the research (Giannakaki, 2005; as cited by Butgel-Tunalı, Gözü, & Özen, 2016). In the current study, using these two methods together provided both complementarity and expansion features. Therefore, quantitative and qualitative methods were employed together in this study for enriching the research, for making more detailed explanations about the research, and for assessing the implementation process as well as the implementation result. Quasi-experimental design was employed in the evaluation phase of the study. The experimental designs are used to determine the cause-effect relationship between the variables (Büyüköztürk, 2007). Examining different conditions existing in the research and not being able to select participants is defined as a quasi-experimental design (Creswell & Clark, 2015).

2.1. Participants

Participants of the research consisted of twenty 10th graders, 12 females and 8 males, from the middle socioeconomic level studying at Multi-Program Anatolian High School located in a district of Bartın, Turkey. The students voluntarily took part in the study. Instead of the students' real names, codes such as S1, S2, …, S20 were used. The research was conducted in the 2018–2019 academic year.

2.2. Data Collection Tools

The FAT, aiming to gauge impact of the method implemented, the scenarios and activities prepared for teaching the topic, and the semi-structured interview form (SSIF), aiming to explore students' opinions, were employed as data collection tools.

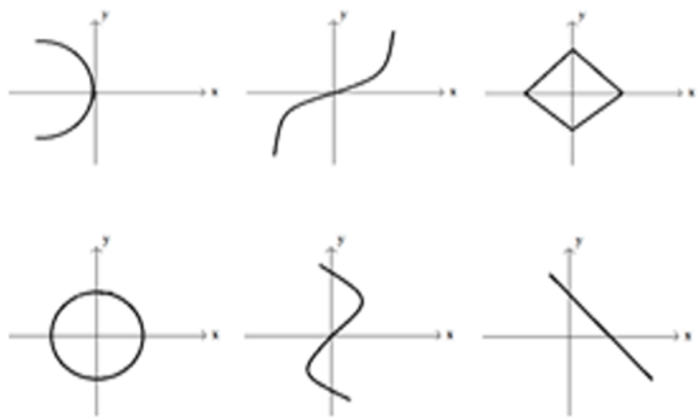
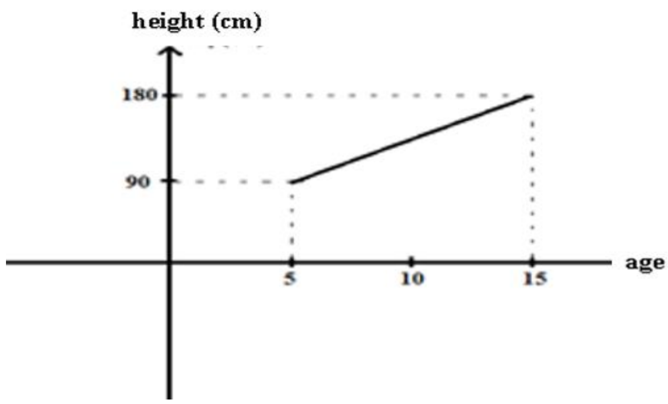
2.2.1. Function Achievement Test (FAT)

A 21-item FAT containing open-ended questions was prepared by making use of mathematics teaching books (Altun, 2010; Baki, 2018; Uygur-Kabael, 2017) and related literature (Cantürk-Günhan, 2006). The learning outcomes related to the topic of functions and graphics included in the secondary education mathematics curriculum (MoNE, 2018) and considered for test preparation were presented in Table 1. FAT questions with representative student answers are included in the Findings section. Content validity of a measuring tool is understood by getting experts' opinions on whether the questions of the measurement tool are suitable for measuring purpose and whether they represent the area to be gauged (Karasar, 2005). To determine the content validity of the questions in the FAT, two content-area experts and two mathematics teachers working at the high school were consulted in terms of content, level, and language, and a pilot application was performed with 15 students. One of the test questions from the pilot application was not understood by the students and led to different perceptions; this question was removed from the test. Following the pilot application, the necessary corrections were made, and it was decided that one lesson hour was enough for answering the test questions. Thus, the final form of the FAT contained 20 open-ended questions (definition of function: 4 questions, types of function: 4 questions, inverse of the function and combination of function: 4 questions and functions graphs: 10 questions). The FAT was applied to the same group as a pretest and a posttest. The questions in the FAT were evaluated by expert review, necessary corrections were made, as a result of the pilot study, and thus the validity of the research questions were ensured. The sample questions of the FAT were given in Table 2.

Table 1. *Learning outcomes regarding the topic of functions and graphics (MoNE, 2018)*

1. The Concept of Function and Its Representation	1.1. Students can solve problems about functions, 1.2. can draw graphs of functions, 1.3. can interpret graphs of functions and make representations of real-life situations that can be expressed with linear functions,
2. Combination of Two Functions and Inverse of a Function	2.1. can make applications about one-to-one and covering functions, 2.2. can make operations regarding the compound process in functions, 2.3. can find the inverse of a given function.

Table 2. *Sample questions of the Function Achievement Test*

Subject	Question
Definition of Function	Please write whether the graphics given below are functional or not, together with their reasons. 
	A new store was opened in a small town. The name of the store is "Crazy Variety Store," and the writing *"Everything is 5 TL!"* on the store window highly attracts people. Accordingly, draw a product-price graph of function reflecting this situation made to attract customers, and determine the type of this function.
Types of Functions	 The graphic in the figure shows height of a boy from 5 to 15 years old. Then, how old does this child have to be to become 160 cm?
Function Graph	Zehra, who drives to İstanbul from Bartın for a summer holiday, consumes 25 TL of fuel when she travels at the speed of 90 km per hour. The fuel consumption increases at the rate of $\frac{1}{5}$ when the car moves 5 km/h faster. Accordingly, draw a graph of Zehra's fuel consumption depending on the speed of her car.

2.2.2. Semi-Structured Interview Form (SSIF)

A five-item SSIF was prepared by the researchers upon getting experts' opinions in order to explore the students' views about the method implemented, and the students were asked to write their answers. In addition, one-to-one interviews were made with six students. The content analysis was conducted by evaluating the data obtained with the codes and categories constructed by the researchers.

2.3. Empirical Study Process

The experimental group consisting of 20 students was divided into 5 groups—4 students per group. The classroom setting was rearranged in order to facilitate communication of the group members and to help them work more comfortably with each other. The students had been informed about the method to be implemented before implementation, and they were informed about tasks to be completed during the study by the students and the teacher. The study lasted for 8 weeks (50 lesson hours). Five scenarios and four activities were implemented in the experimental group. The FAT was administered as a pretest before and a posttest after the implementation. The students were asked to write their views about the method implemented, and one-to-one interviews were carried out with six of them.

2.4. Data Analysis

Quantitative data analysis techniques were employed to reveal if teaching the topic of functions by associating it with everyday life caused any statistically significant differences between pretest and posttest scores of the students.

The analysis of the 20-question Function Achievement Test (FAT), which was prepared as open-ended by the researchers, was done with quantitative data analysis techniques. Research data was obtained by examining students' answer sheets. For this, firstly, the correct answers of the students to open-ended questions were scored as 1, and the incorrect and unanswers were scored by the researchers as 0. Then, due to the small number of students in the group, the analysis between dependent groups was carried out using the non-parametric test Wilcoxon Signed-Ranks Test, using the SPSS 22.00 statistics program.

Then, the answers given by the students to the FAT were scored by two researchers as completely correct, partially correct (a), partially correct (b), incorrect, and unanswered by considering the framework of Şahin, Erdem, Başıbüyük, Gökkurt and Soylu (2014) given in Table 3. To provide reliability of the study, scoring was performed by two researchers, and consistency percentage was calculated according to Miles and Huberman (1994). The consistency percentage found was 93%. The researchers agreed on their discussions for the remaining 7% difference. Hence, perfect consistency between the coders (100%) was provided. Second, frequency values of students' pretest and posttest answers related to these codes aiming to determine their mathematics achievement levels were interpreted in tables, and direct examples of students' answers were given.

The analysis of qualitative data obtained from the interview form prepared for answering the third sub-problem of the research was performed by content analysis. The aim of content analysis is to reach concepts and relations that would explain the data gathered. The data are conceptualized, organized logically, and themes explaining the data are detected (Yıldırım & Şimşek, 2018). The data of the current study were classified into codes and categories by the researchers, and the consistency percentage found was 95% according to Miles and Huberman (1994). For the remaining 5% difference, the researchers agreed upon their discussions. Thus, full consistency (100%) was achieved by increasing the consistency between the coders.

Table 3. *The codes for the students' responses and scoring values corresponding to these categories*

Response Category	Completely Correct	Partially Correct (a)	Partially Correct (b)	Incorrect	Unanswered
Scoring Values	4	3	2	1	0

As can be seen in Table 3, a 5-point grading system related to the students' responses was employed. These were **Completely Correct:** correct responses containing all of the scientific ideas regarding the questions; **Partially Correct (a):** responses containing nearly all correct scientific ideas regarding the questions with minor errors; **Partially Correct (b):** responses that are nearly incorrect with few accurate scientific ideas; **Incorrect:** responses that are lacking in accurate scientific ideas regarding the questions and unrelated to the questions; and Unanswered: the questions that are left blank. The questions in the FAT were coded as Q1, Q2, …, Q20.

3. Research Questions

The main research question of the study was "What is the effect of utilizing scenario-based instruction to teach "Functions" to high school students in Mathematics classes?" Based on this main research question, the sub-research questions are as follows:

1. "Does teaching implemented with scenarios on functions make a significant difference between the pretest and posttest scores of 10th grade students?"

2. "What are the 10th grade students' response categories for the questions in the test on functions learned by instruction with scenarios?"

3. "What are the views of 10th grade students regarding the method implemented while teaching the topic of functions?"

4. Findings

The findings related to the analysis of the students' responses to the questions in the FAT about the topic of functions.

4.1. Findings Related to the First Sub-Research Question

The findings related to the first sub-research question "Does teaching implemented with scenarios on functions make a significant difference between the pretest and posttest scores of 10th grade students?" are given in Table 4.

Table 4. *Wilcoxon Signed-Ranks Test results of FAT scores before and after the implementation*

Posttest-Pretest	N	Mean Rank	Sum of Ranks	z	p
Negative Ranks	0	.00	.00	3.92*	.000
Positive Ranks	20	10.50	210.00		
Ties	0	-	-		

*Based on negative ranks

The Wilcoxon signed-ranks test results aiming to reveal whether teaching the topic of functions with scenarios significantly affected the students' mathematics achievement were presented in Table 4. The results indicated that there was a significant difference between the students' pretest and posttest FAT scores ($z = 3.92$, $p < .00$). When mean rank and sum of ranks were considered, it was seen that the difference was in favor of negative ranks, that is, of the posttest scores. These results showed that teaching the topic of functions with scenarios improved the students' mathematics achievement levels.

4.2. Findings Related to the Second Sub-Research Question

Analysis of the qualitative findings related to the second sub-research question "What are the 10th grade students' response categories for the questions in the test on functions learned by instruction with scenarios?" is presented in Table 5.

Table 5. *The categories and frequencies regarding the students' responses for the questions in the pretest and the posttest about the definition of function*

	Pre-test					Post-test				
Questions	Q1	Q2	Q4	Q5	f(%)	Q1	Q2	Q4	Q5	f(%)
Categories										
Completely correct	4	1	-	8	13(16.25)	11	1	3	10	25(31.25)
Partially correct (a)	3	-	2	-	5(6.25)	2	3	9	3	17(21.25)
Partially correct (b)	4	6	7	4	21(26.25)	4	11	5	4	24(30.00)
Incorrect	5	7	5	3	20(25.00)	2	3	-	2	7(8.75)
Unanswered	4	6	6	5	21(26.25)	1	2	3	1	7(8.75)
Total					80 (100)					80(100)

-: no data in the relevant category.

The categories, frequencies, and percentage distributions of the responses given to the questions in the pretest about the definition of function were shown in Table 5. According to the table, 51.25% of the student responses in the pretest were in the categories of incorrect and unanswered. In these categories, the students mostly gave incorrect responses to Q1, Q2 and Q4, respectively. It was understood that the students had serious knowledge deficiency in determining whether there was a function when they were given a function graph. In this context, S2's response is given in Figure 1.

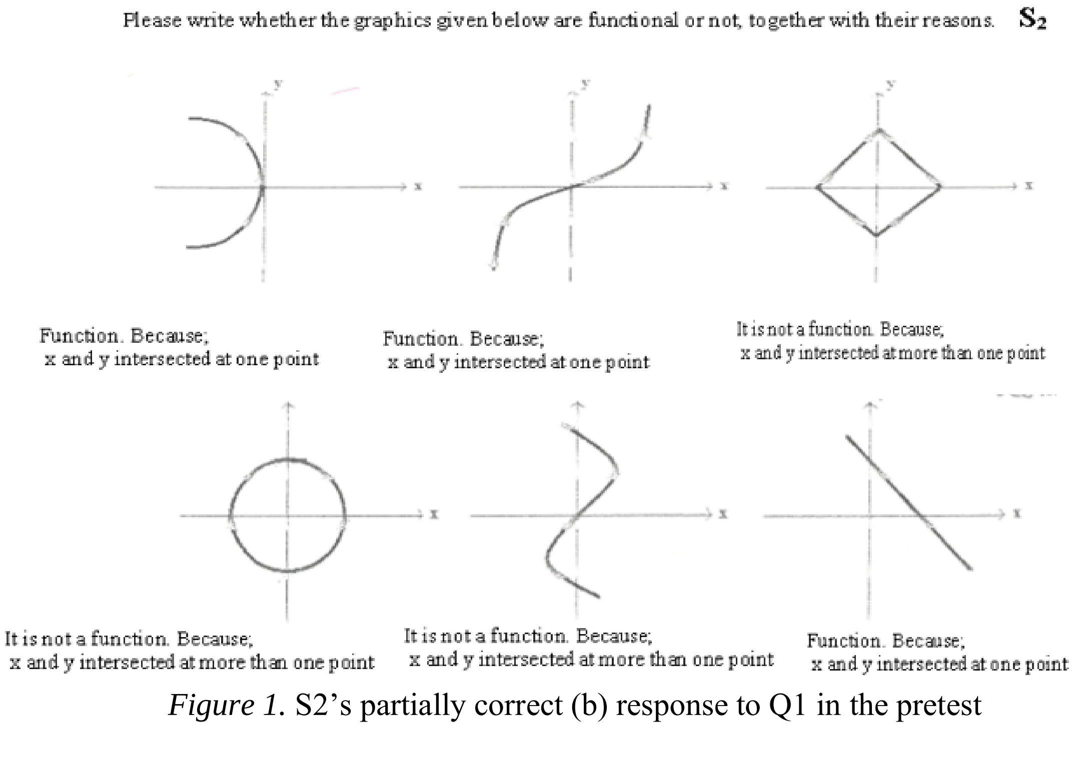
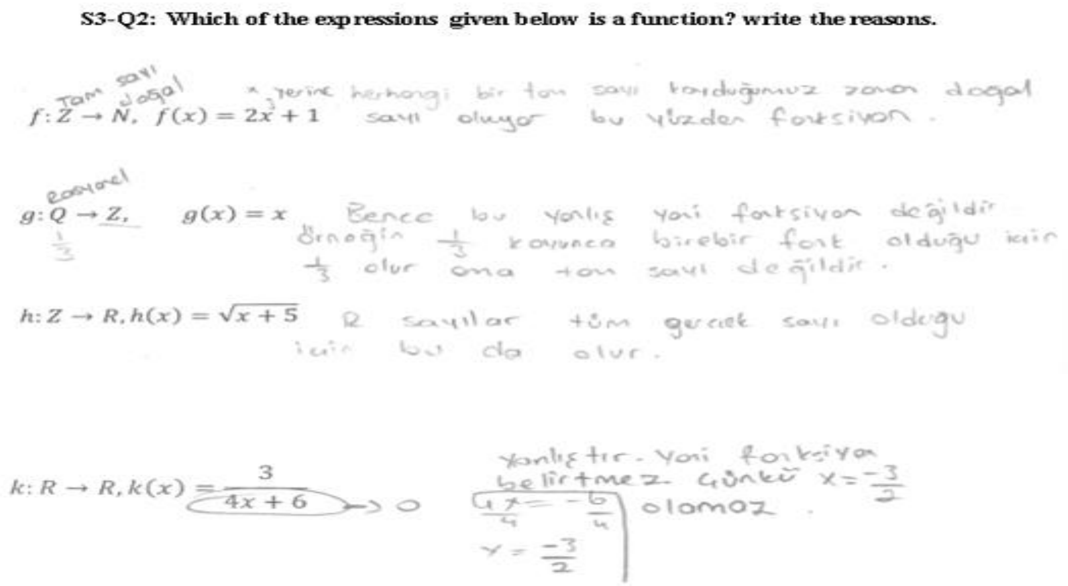


Figure 1. S2's partially correct (b) response to Q1 in the pretest

Based on the answers given in Figure 1, it can be said that S2 does not know the definition of function exactly, that is, does not have the knowledge that each x value in the domain needs to match one and only one element in the image set. In addition, while the student had to apply the vertical line test, he decided whether there was a function by looking at how many times x and y axes intersected in the graphs given. Although this method used by the student gave the correct result in some graphic questions, the student's response was regarded in the category of partially correct (b) as the method was wrong.



S3-Q2

$f: \mathbb{Z} \rightarrow \mathbb{N}, f(x) = 2x + 1$, When we put any integer in place of x, it becomes a natural number, so it is a function.

$g: \mathbb{Q} \rightarrow \mathbb{Z}, g(x) = x$, I think this is wrong, so it is not a function. For example, when you put $\frac{1}{3}$ it becomes $\frac{1}{3}$ because there is a one-to-one difference, but it is not an integer.

$h: \mathbb{Z} \rightarrow \mathbb{R}, h(x) = \sqrt{x+5}$ Since R is for real numbers, this is also function.

$k: \mathbb{R} \rightarrow \mathbb{R}, k(x) = \frac{3}{4x+6}$ It is wrong. That is, it does not specify a function. Because it cannot be

$x = -\frac{3}{2}$

Figure 2. S3's partially correct (b) response to Q1 in the pretest

According to Figure 2, S3 answered the definition of algebraic relations as "the definition of functions and codomains" regardless of f and h relations. Therefore, the student's response was regarded in the category of partially correct (b). Bourbaki (1939) described function as a special relation making matches between elements of two (as cited by Markovits, Eylon, & Bruckheimer, 1986). The definition of function in today's modern mathematics books is as follows: "Let A and B be two non-empty sets, and f be a relation from A to B. If f relation relates every element in set A to one and exactly one element in set B, this relation is called as a function from A to B." Based on this definition, none of the expressions given for the question can be a function.

The categories, frequencies, and percentage distributions of the students' responses to the questions about the definition of function in the posttest were also given in Table 5. According to the table, 82.5% of the student responses were completely correct, partially correct (a), and partially correct (b). It was seen from Table 5 that the number of incorrect responses decreased considerably in the posttest compared to the pretest. Most of the students applied the vertical line test accurately in the graphic questions. Accordingly, completely correct posttest answers of S2, whose response to Q1 was partially correct (b) in the pretest, are given in Figure 3.

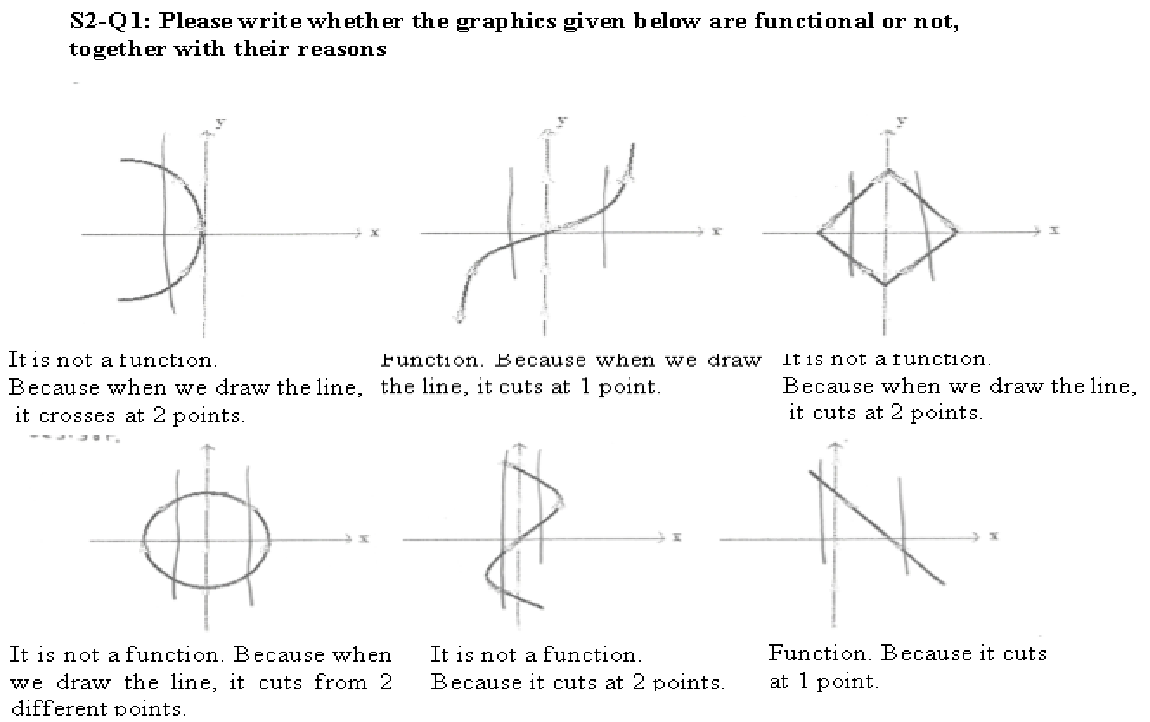


Figure 3. S2's completely correct response to Q1 in the posttest

As can be seen in Figure 3, S2 applied the vertical line test and expressed that if a vertical line drawn in the graphics cross the graphic at one point, it is a function, but it is not a function if it crosses more than once. On the other hand, as illustrated in Table 5, the students had deficiencies in deciding whether an algebraic expression given was a function or not. In this context, the response of S9, who was the only one to answer Q2 correctly in the posttest, was presented in Figure 4.

S9-Q2: Which of the expressions given below is function? write the reasons.

$f: \mathbb{Z} \to \mathbb{N}, f(x) = 2x + 1$, It is not a function. The negative number placed in turns out to be negative again. But it must be a Natural number. That is, not every number in the definition set is in the image set.

$g: \mathbb{Q} \to \mathbb{Z}, g(x) = x$, It is not a function. A rational number from the definition set turns out just like itself. But it has to be an integer.

$h: \mathbb{Z} \to \mathbb{R}, h(x) = \sqrt{x+5}$ It is not a function. If the result is negative when a negative number is placed in, it is not a function because of the root 2

$k: \mathbb{R} \to \mathbb{R}, k(x) = \frac{3}{4x+6}$ It does not specify a function. If the real number $x = -\frac{3}{2}$ is thrown in, the denominator becomes zero (0). So it does not specify a function.

Figure 4. S9's completely correct response to Q2 in the posttest

Table 6. *The categories and frequencies regarding the responses of the students for the questions about types of functions in the pretest and posttest*

	Pretest			Posttest		
Questions Categories	Q3	Q6	f(%)	Q3	Q6	f(%)
Completely correct	-	4	4(10.00)	7	16	23(57.5)
Partially correct (a)	10	-	10(25.00)	8	3	11(27.5)
Partially correct (b)	9	-	9(22.50)	4	-	4(10.00)
Incorrect	-	8	8(20.00)	1	-	1(2.5)
Unanswered	1	8	9(22.50)	-	1	1(2.5)
Total			40(100)			40(100)

-: no data in the relevant category

Table 6 contains the categories, frequencies, and percentage distributions of the responses given to the questions about types of functions in the pretest and the posttest. According to the table, 35% of the student pretest responses were in the categories of completely correct and partially correct (a). It was noteworthy that students wrote 'composite' or 'entire' functions when determining the types of functions in the questions given by the table representations. It was clear that they did not know much about the concepts of unit and constant functions. The response of S20 given in Figure 5 exemplifies this fact.

S20-Q6

6)A new store was opened in a small town. The name of the store is "Crazy Variety Store," and the writing ***"Everything is 5 TL!"*** on the store window highly attracts people. Accordingly, draw a product-price graph of function reflecting this situation made to attract customers, and determine the type of this function.

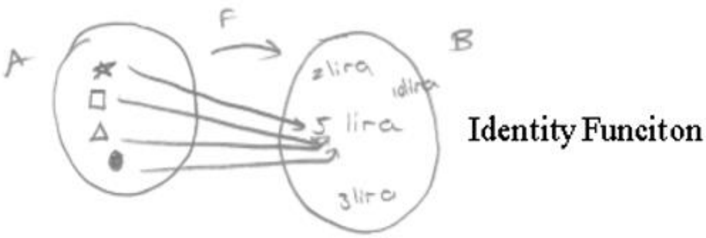


Figure 5. S20's incorrect response to Q6 in the pretest

According to Figure 5, S20 showed the situation given in the 6th question via cluster mapping accurately, yet his response was regarded in the incorrect category since he was not able to determine the type of function and to illustrate this on a graphic.

The categories, frequencies, and percentage distributions of the student responses for the questions about types of functions in the posttest were also presented in Table 6. According to the table, 85% of the student responses were in the categories of completely correct and partially correct (a). Most of the students responded to Q6, which was left blank by only one student, in the category of completely correct. S1's response was given in Figure 6. Additionally, 85% of the students responded to Q3, which was about types of functions, in the categories of completely correct or partially correct (a). Thus, it can be concluded that the students became successful in determining the types of functions following the implementation of scenario-based instruction.

S1-Q6

6)A new store was opened in a small town. The name of the store is "Crazy Variety Store," and the writing ***"Everything is 5 TL!"*** on the store window highly attracts people. Accordingly, draw a product-price graph of function reflecting this situation made to attract customers, and determine the type of this function.

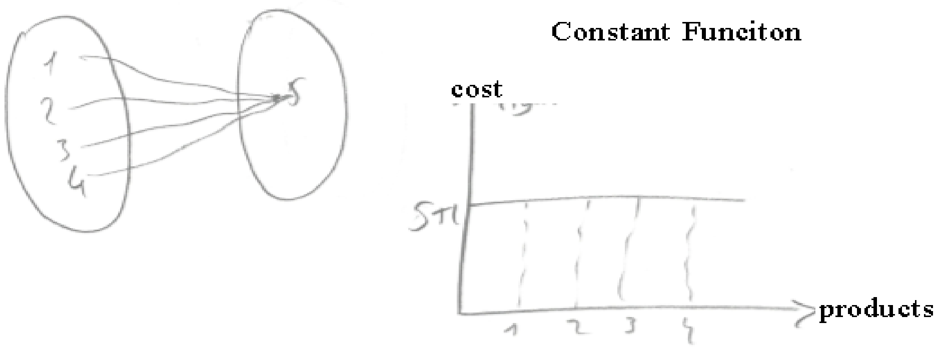


Figure 6. S1's completely correct response to Q6 in the posttest

When S1's response in Figure 6 was analyzed, it was seen that the student wrote the type of function correctly and supported it with cluster mapping and table representation of the graphic. Therefore, S1's response was regarded as completely correct.

Table 7. *The categories and frequencies regarding the student responses for the questions in the pretest and posttest related to operations in functions, inverse of the function, and combination of functions*

	Pretest					Posttest				
Questions	Q9	Q18	Q19	Q17	f(%)	Q9	Q18	Q19	Q17	f(%)
Categories										
Completely correct	1	-	17	-	18(22.50)	4	2	20	7	33(41.25)
Partially correct (a)	1	-	1	1	3(3.75)	6	-	-	6	12(15.00)
Partially correct (b)	8	1	2	-	11(13.75)	6	-	-	4	10(12.50)
Incorrect	2	12	-	1	15(18.75)	3	14	-	2	19(23.75)
Unanswered	8	7	-	18	33(41.25)	1	4	-	1	6(7.50)
Total					80(100)					80(100)

-: no data in the relevant category.

The categories, frequencies, and percentage distributions of the student responses for the questions in the pretest about operations in functions, the inverse of functions, and the combination of functions were given in Table 7. According to the table, 60% of the student responses were in the categories of incorrect and unanswered. While doing addition, most of the students disregarded the knowledge of "operations can be performed only with functions when domains of functions are the same (common)" by thinking of the definition of a composite function. S11's response to Q9 was given in Figure 7.

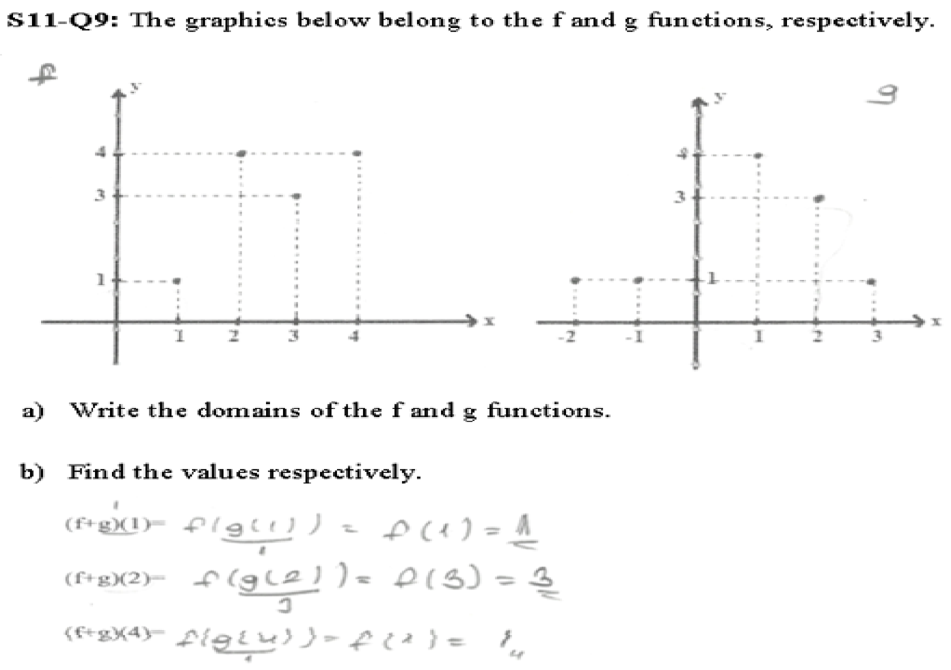


Figure 7. S11's incorrect response to Q9 in the pretest

It was seen in Figure 7 that S11 performed the operation without determining domains of functions in the ninth question in the pretest. He performed the operation by writing equality as (f +g) (1) = f (g (1)) although he was expected to write equality as (f +g) (1) =f (1) +g (1). S11 was not able to distinguish the topics of addition in functions and determination of compounds in functions. In addition, he neglected the fact that function g was not defined at the x=4 point and that the g (4) value could not be counted. However, most of the students wrote x=3 in set C without writing the rule of function in order to find the value at the point of x=3 for the 18th question about the composite process of functions. In this context, S5's response was given in Figure 8.

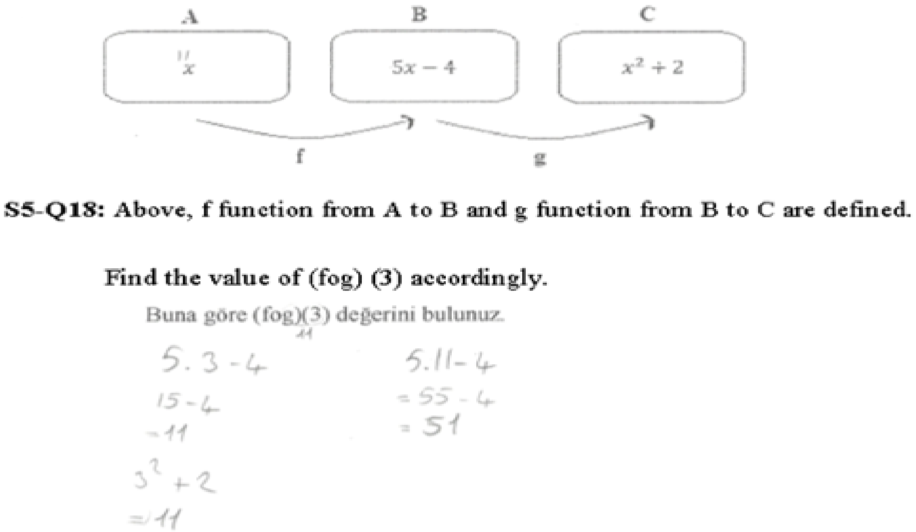


Figure 8. S5's incorrect response to Q18 in the pretest

S5 should have written the domain and codomain of the functions f and g with the rules of functions as f: A→B, f(x)=5x-4 and g: B→C, g (5x-4) = x^2+2. However, Figure 8 indicated that S5 wrote 3 although he should have written 1 for x in set B for function g, as he thought that the g (3) value was required to be found. Contrarily, S5 should have solved the question by considering what value needed to be written instead of the x value for equalizing (5x-4) to 3. Therefore, S5's response was regarded as incorrect.

The categories, frequencies, and percentage distributions of the student responses for the questions in the posttest about operations in functions, the inverse of functions, and the combination of functions were given in Table 7. According to the table, 68.75% of the student responses were in the categories of completely correct, partially correct (a), and partially correct (b). A majority of the student mistakes were eliminated, and the students gained the knowledge that the four basic operations can be performed only in functions having a common domain. S10's response in Figure 9 reflected this situation. It was seen in Figure 9 that S10 first identified domains of the functions and then added up in the functions. He responded to the question correctly by expressing that the function g was not defined at the point of x=4 and that the value of g (4) could be undefined in (f + g) (4) = f (4) +g (4). Therefore, S10's response was regarded as completely correct.

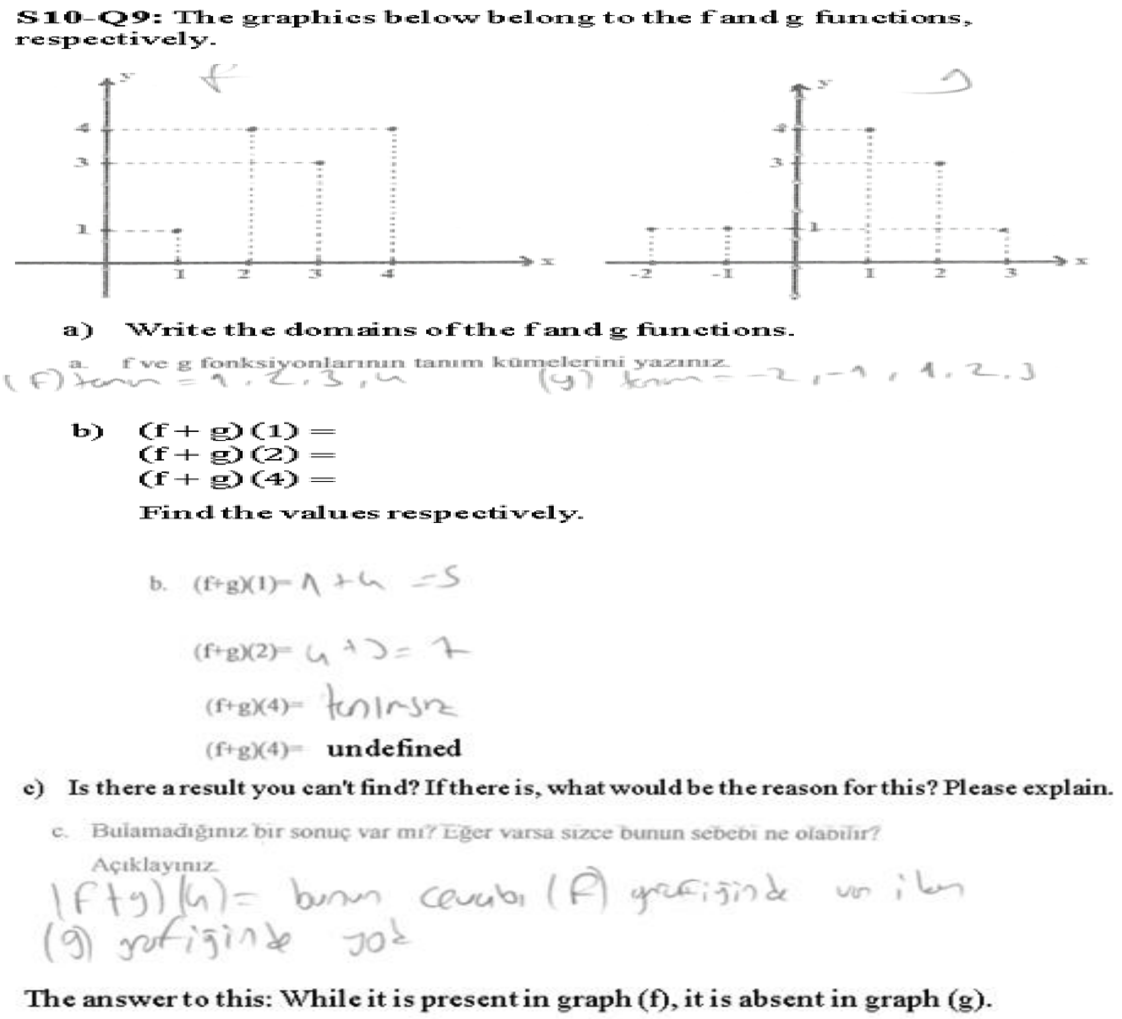


Figure 9. S10’s completely correct response to Q9 in the posttest

The response of S3, who was the only one with the completely correct score in the posttest, was given in Figure 10. It was understood that the students had difficulty in the 18th question for which no completely correct response existed. However, S3 answered the 18th question correctly by providing reasoning. Therefore, S3’s response was regarded as completely correct.

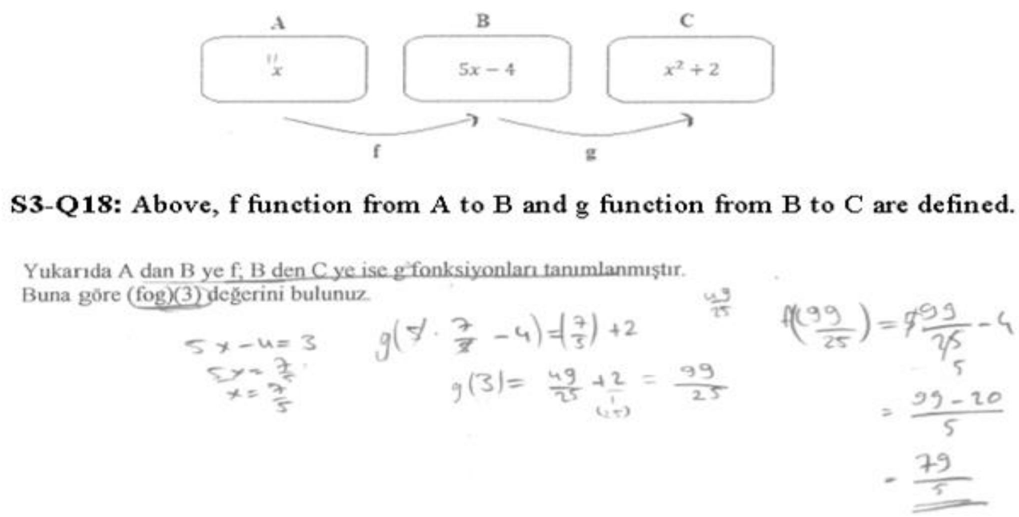


Figure 10. S3’s completely correct response to Q18 in the posttest

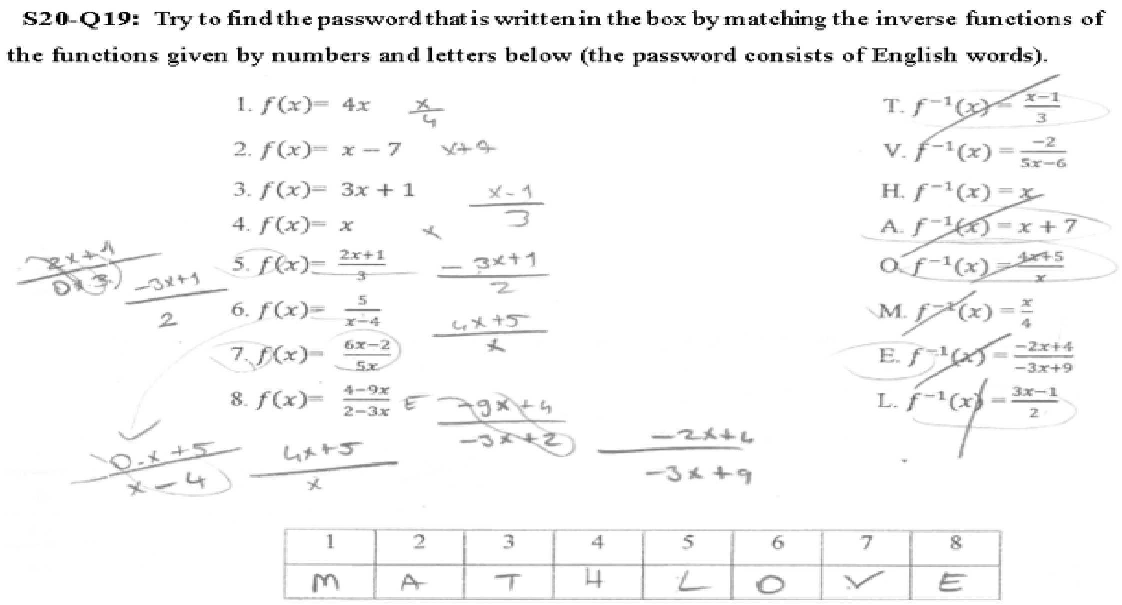


Figure 11. S20's completely correct response to Q19 in the posttest

As seen in Table 7, Q19 was the only question that all of the students answered correctly. As S20's response in Figure 11 shows, the students deciphered the password accurately by easily finding the inverse of the function.

Table 8. *The categories and frequencies regarding the student responses for the questions about function graphs in the pretest*

Pretest Questions Categories	Q7	Q8	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q20	f(%)
Completely correct	2	2	4	1	1	-	2	-	2	-	14(7.00)
Partially correct (a)	-	-	8	-	3	1	1	1	3	3	20(10.00)
Partially correct (b)	-	9	6	2	-	2	1	9	2	4	35(17.50)
Incorrect	12	4	1	10	9	13	9	1	3	3	65(32.50)
Unanswered	6	5	1	7	7	4	7	9	10	10	66(33.00)
Total											200(100)

-: no data in the relevant category.

The categories, frequencies, and percentage distributions of the student responses for the questions about function graphs in the pretest were presented in Table 8. According to the table, 65.50% of the student responses were in the categories of incorrect and unanswered. The students' responses related to the function graphs were given as follows.

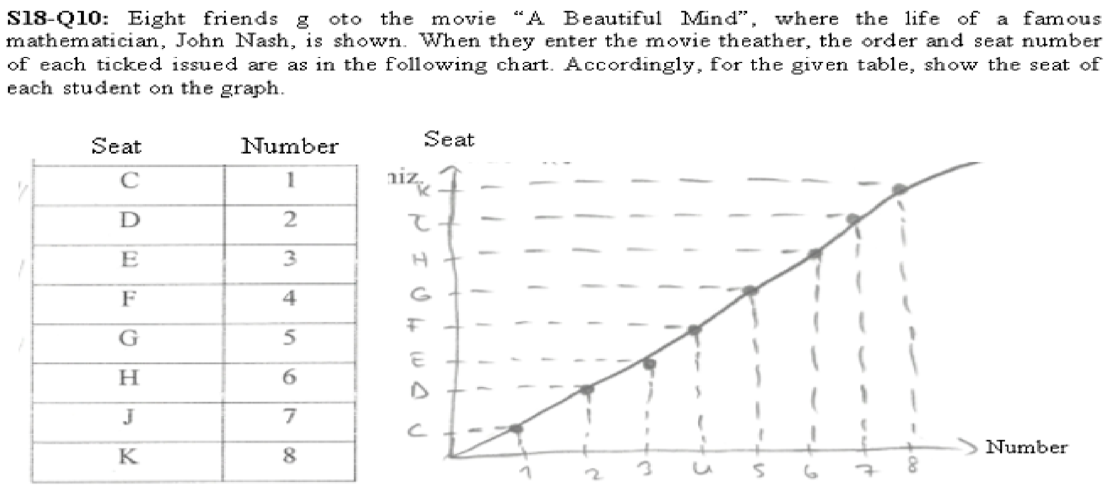


Figure 12. S18's incorrect response to Q10 in the pretest

The 10th question in which the students were asked to draw a graphic of the function for which a table was given was as follows: "8 friends go to the movies to watch 'A Beautiful Mind,' which was about the life of John Nash—a famous mathematician. When they enter the cinema hall, the row and seat number of the ticket issued for each are given in the table. Then, show the seat of each student on a graph for the given table." In Figure 12, S18 connected the dots while drawing a graphic for the 10th question after marking these dots in the graphic, disregarding domains and codomains of the function. However, a function graph can also be in the form of a graph consisting only of ordered pairs (Baki, 2018). The student connected the dots determined in the graph by ignoring the knowledge that not all of the functions have to have an algebraic rule (Uygur-Kabael, 2017). Therefore, S18's response was regarded in the category of incorrect.

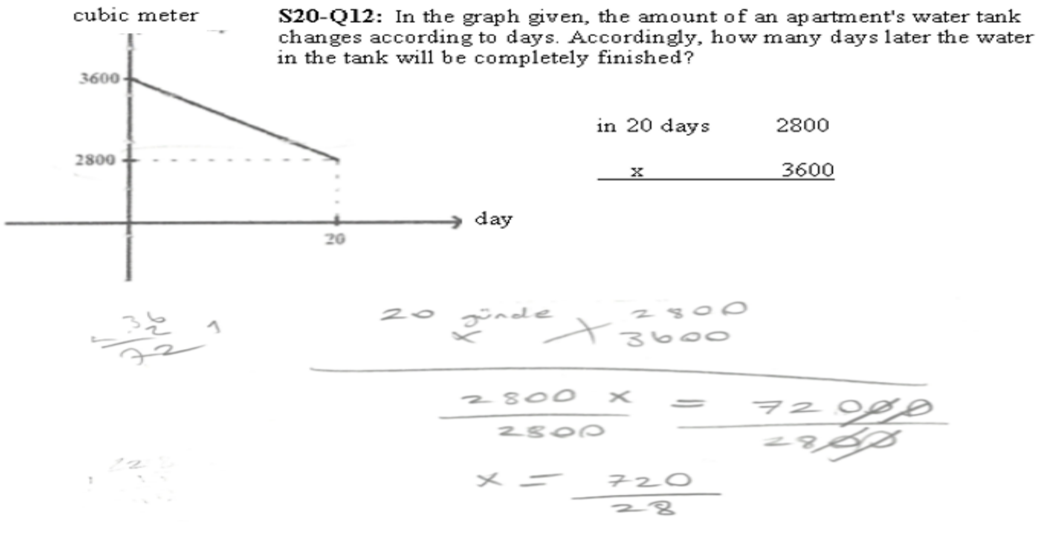
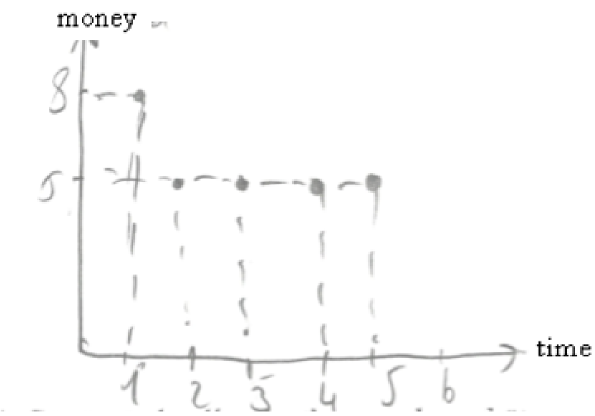


Figure 13. S20's incorrect response to Q12 in the pretest

As seen in Figure 13, S20 tried to find the answer by proportioning instead of solving the 12th question in the pretest by using the definition of the linear function. He should have proportioned as "If 800 cubic meters of water is spent in 20 days, how many days are needed to spend 3600 cubic meters?" However, the student responded to the question incorrectly by proportioning the amount of water in the tank at the end of 20 days instead of finding the difference between the amount of water in the beginning and at the end of 20 days. Therefore, S20's response was regarded as incorrect.



S1-Q13: Parking fee is determined as 8 liras for the first hour in a parking lot. It is necessary to pay 5 liras for every hour after one hour. Accordingly, plot a time-dependent graph of a vehicle remaining in this parking lot for 6 hours.

Figure 14. S1's incorrect response to Q13 in the pretest

It was seen in Figure 14 that S1 ignored the information that the function graph needs to be constant, and the amount needed to be paid for the car park cannot be fixed. Hence, he responded to the question incorrectly. Therefore, S1's response was regarded in the category of incorrect.

S9-Q20: Plot the function f. Also find the inverse of the given function and show it on the graph. Explain how you made a conclusion.

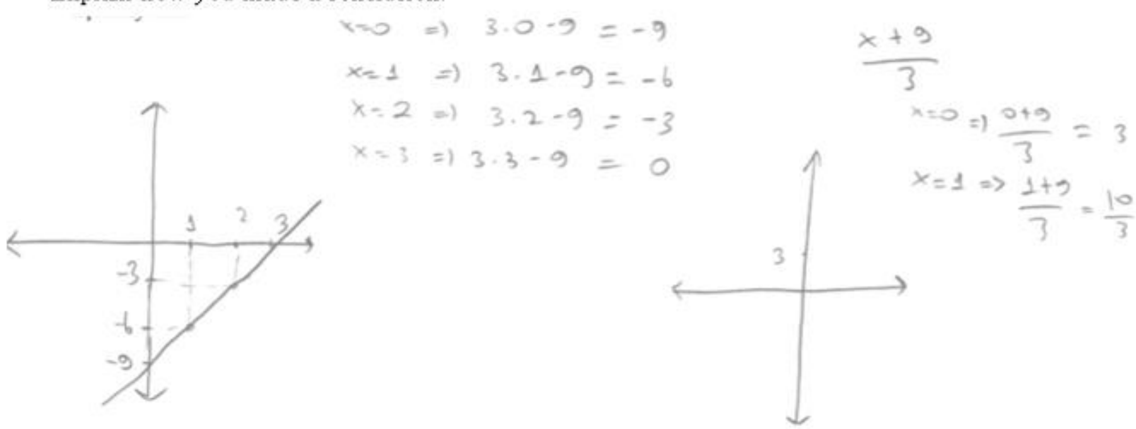


Figure 15. S9's partially correct (a) response to Q20 in the pretest

According to Figure 15, S9 made the graphical representation of the function given as an algebraic expression correctly and found the inverse of the function correctly as well. However, he could not show the inverse of the function on the graph, and he could not conclude that the inverse of a function would be symmetrical to the graph of its function with respect to the line y=x. Therefore, the student's response was regarded in the category of partially correct (a).

Table 9. *The categories and frequencies regarding the student responses for the questions about function graphs in the posttest*

Posttest Questions / Categories	Q7	Q8	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q20	f(%)
Completely Correct	6	8	12	1	10	1	2	2	5	1	48(25.26)
Partially Correct (a)	9	9	8	6	2	6	5	7	-	11	63(33.15)
Partially Correct (b)	2	1	-	4	4	8	1	4	4	4	32(16.84)
Incorrect	1	-	-	6	2	4	6	6	6	-	19(10.00)
Unanswered	2	2	-	3	2	1	6	5	5	4	28(14.73)
Total											190(99.98)

-: no data in the relevant category

The categories, frequencies, and percentage distributions of the student responses for the questions about function graphs in the posttest were given in Table 9. According to the table, 25.26% of the student responses were in the category of completely correct. The students mostly responded to Q10 and Q12 in the category of completely correct, but they were not able to respond to Q20 in this category. On the other hand, nearly half of the students gave responses in the categories of partially correct (a) and partially correct (b). Some examples of the student responses for the questions about function graphs in the posttest are presented below.

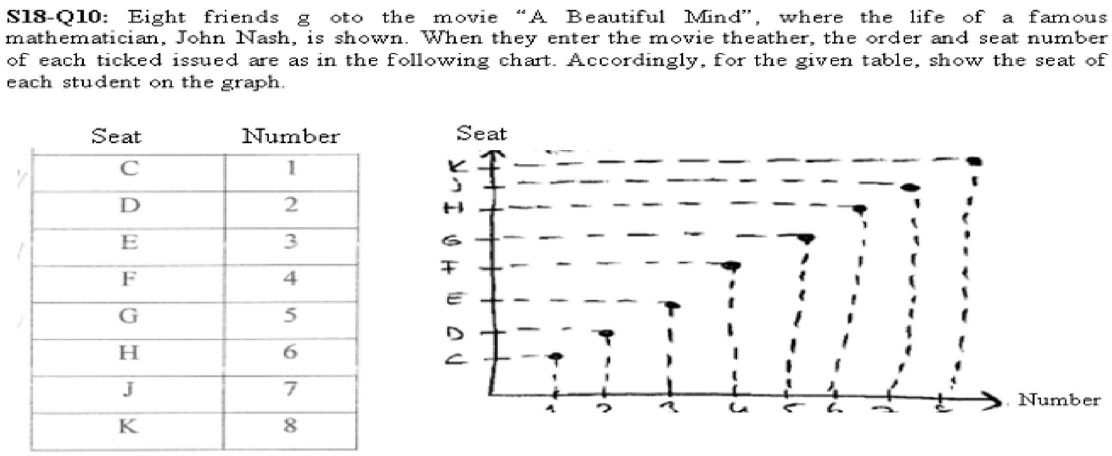


Figure 16. S18's completely correct response to Q10 in the posttest

Figure 16 showed that in the posttest, S18 correctly responded to the question which he responded incorrectly to in the pretest. Within the context of the question, the student's response was regarded in the category of completely correct since dots moved to the graph should not be connected.

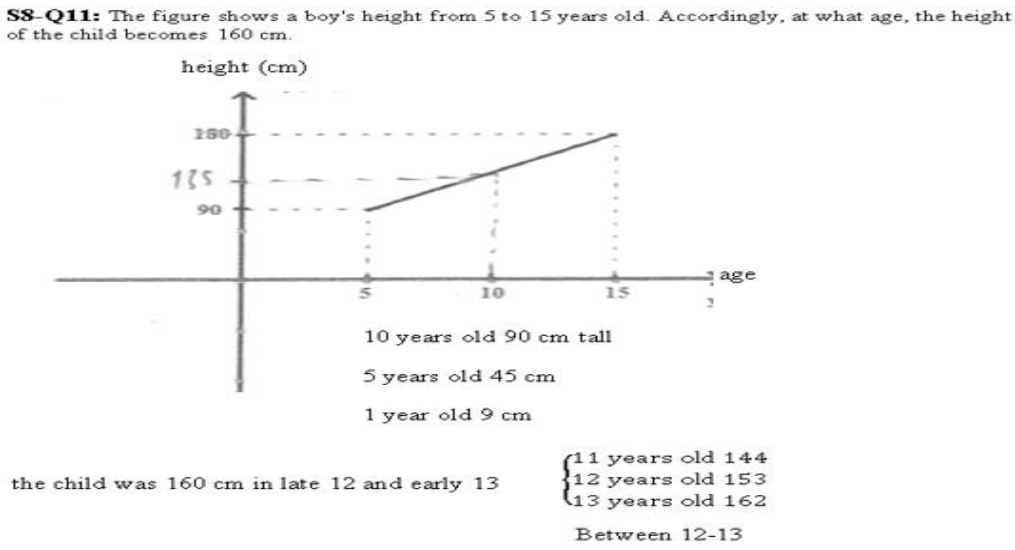


Figure 17. S8’s completely correct response to Q11 in the posttest

According to Figure 17, S8, who responded to the 11th question in the category of completely correct in the posttest, demonstrated reasoning ability including proportional reasoning and prediction and deduction (Lesh, Post, & Behr, 1987). With the information that the child is 9 cm longer each year, he reached the correct result by finding out what age the child would be when he reached 160 cm in length.

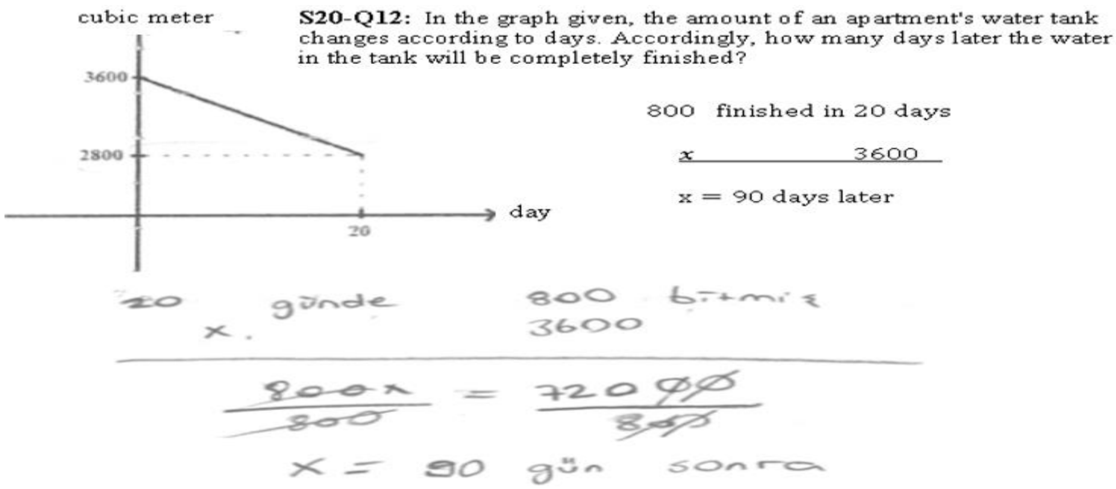


Figure 18. S20’ s completely correct response to Q12 in the posttest

As seen in Figure 18, S20 found the correct response by providing proportional reasoning as well as by benefitting from the definition of a linear function. Therefore, S20’s response was regarded in the category of completely correct.

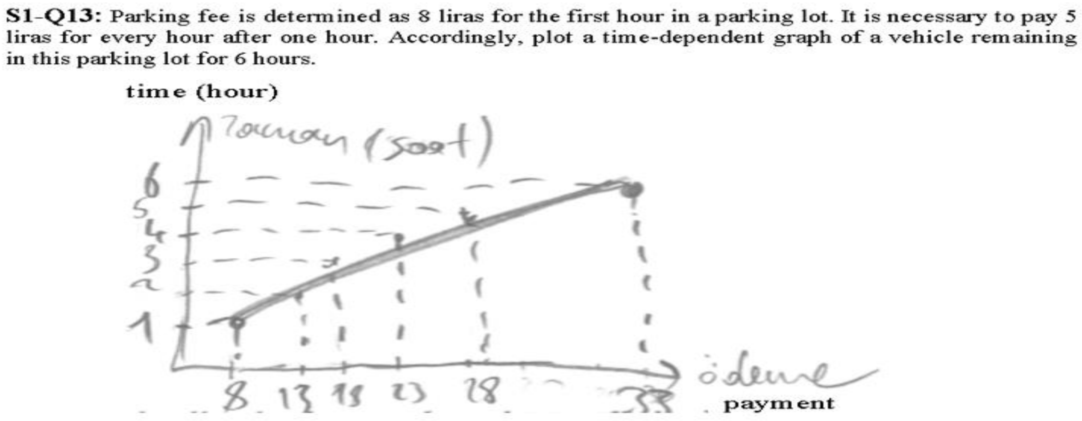


Figure 19. S1's completely correct response to Q13 in the posttest

S1's completely correct response to the 13th question in the posttest can be seen in Figure 19. S1 found the amount needed to be paid 6 hours later accurately by creating a time-paid rate graphic. S1's graphic showing that parking fee increases every hour is correct, so his response was regarded in the category of completely correct.

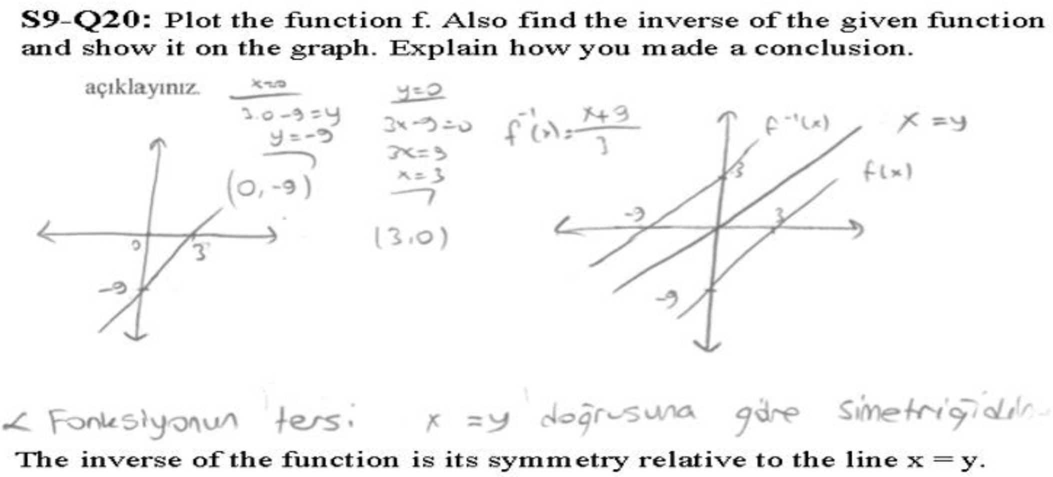


Figure 20. S9's completely correct response to Q20 in the posttest

As seen in Figure 20, S9 found the inverse of the function after drawing the graphic of a function with an algebraic expression. Drawing the graphic of the inverse of the function accurately, the student made the inference that the graph of the inverse of the function was symmetrical with respect to the line y=x. Thus, the student's response was regarded as completely correct.

4.3. Findings Related to the Third Sub-Research Question

In this section, the qualitative findings related to the third sub-research question "What are the views of 10th grade students regarding the method implemented while teaching the topic of functions?" are presented.

Table 10. *The students' views on instruction with scenarios*

Categories	Codes	Subcodes	f	Total(%)
Positive views	Views on instruction with scenarios	Its making information more consistent	4	30(26.08)
		Its making lessons more enjoyable	12	
		Its benefits for revealing thoughts	4	
		Its making the topic clear/Its making comprehension easier	4	
		Its contribution to the reinforcement	3	
		Its attracting attention	1	
		Its need for more time	1	
		Its promoting creativity	1	
	Views on learning the topic	Establishing a relationship between mathematics and everyday life/making understanding easier	6	24(20.86)
		Understanding the topic of functions better/making comprehension easier	8	
		Realizing that mathematics is in daily life/using it	6	
		Expressing oneself better/expressing thoughts	1	
		Realizing and eliminating the deficiencies about previous topics	1	
		Its contribution to drawing graphics and creating a function rule	2	
	Design of scenarios and activities	Enjoyable	3	17(14.78)
		Related to everyday life	10	
		Instructive/Permanent	1	
		Understandable	2	
		Interpretation-promotive	1	
	Views on implementation	Out of formulas-plain mathematics	1	36(31.30)
		Its getting easier as time flows	2	
		Easy progress of the lessons	9	
		Instruction's being more understandable with scenarios	4	
		Previous mathematics lessons' being difficult and incomprehensible, yet instruction being more comprehensible with scenarios	5	
		Its being understood better compared to the previous topics	6	
		Not writing too many things on the notebook	2	
		Lessons' being more enjoyable	4	
		Teaching different topics with scenarios as well	1	
		Teaching with daily life problems	2	
Negative views	Views on implementation	Inadequacy of operational knowledge	1	6(5.21)
		Encountering such an implementation for the first time	1	
		Inclusion of verbal texts	1	
		The topics' being associated	1	
		Causing waste of time	1	
		Not contributing to reveal mathematical ideas	1	
	Views on its contribution for learning the topic	Distraction in lessons	1	2(1.73)
		Inclusion of algebraic expressions	1	
				115(99.96)

Table 10 depicted that 93.02% of the student views on instruction in relation to daily life were positive. Twenty percent and eighty-six percent of consisted of views on teaching with scenarios. The students stated that especially instruction with scenarios made the lessons more enjoyable. “Its making information consistent,” “its benefits for revealing thoughts,” and “its making comprehension easier” followed this situation. The students expressed that learning the topic of functions via real-life related situations is useful for eliminating deficiencies about previous topics. As shown in Table 10, 14.78% of the students stated that designed scenarios and activities were related to daily life, enjoyable, and clear.

According to Table 10, 31.30% of the student views were that lessons were taught more easily with scenarios and activities; the previous mathematics lessons were difficult, boring and complicated; instruction with scenarios made lessons easier; the topics were understood better; and lessons became more fun and enjoyable. The students also mentioned that they achieved permanent learning. The student views in Table 10 revealed that the students had gotten bored in previous mathematics lessons as they had written too much on their notebooks, but instruction with scenarios made lessons more enjoyable. One of the salient responses in the student interview forms was that instruction with scenarios was different and difficult for students at the beginning.

5. Discussion and Conclusion

5.1. Impact of Instruction with Scenarios on Students’ Mathematics Achievement

It was found in the present study that the scenario-based instruction method which was applied to the experimental group of students promoted their mathematics achievement regarding the topic of functions and function graphs. Our study results suggest that the improvement in their mathematics achievement was due to the scenario-based instruction conducted based on daily life problems and on student collaboration and discussion. The topic of functions acts as a bridge between most mathematics topics. Hence, it is an important foundation for the students’ improvement in other mathematical processing skills such as reasoning and questioning (NCTM, 2009). As Hiebert and Lefevre (1986) stated in their research, it is possible for students to develop conceptual knowledge with the skill of association. Within this context, the topic of functions was taught with scenarios prepared through real-life association, and the impact of implementation on students’ mathematics achievement was investigated. As a result of the study, real-life related teaching resulted in a significant difference between students’ pretest and posttest FAT scores regarding the topic of functions. This finding indicates that teaching the topic of functions by supporting it with real-life examples can promote students’ achievement in the topic of functions.

5.2. Investigation of the Students’ Response Categories to Scenario-Based Teaching

The qualitative data relating to mathematics achievement on the topic of functions from the experimental group was analyzed. The students’ answers to the questions about functions and function graphs in the pretest were mostly incorrect, but there were significant improvements in their posttest answers compared to the pretest. When the posttest data were analyzed as a whole, the students performed better than they did prior to implementation.

When the pretest data of the questions related to the definition of function were examined, it was observed that the students generally had deficiencies in determining whether a given graph was a function or not. The students decided whether the given graphs were functions especially by checking how many dots x and y axes intersected. Therefore, it was revealed that more than half of the student responses were in the categories of incorrect and unanswered. The posttest data showed that a large number of students comprehended the definition of function. The students were able to explain the reasons for their responses accurately. However, very few students had difficulty in deciding whether an algebraic expression was a function or not in the pretest. The students had more difficulties in determining the types of functions and in the algebraic representation of expressions rather than the graphic representation of the definition of the function, but such difficulties decreased significantly following implementation of instruction.

The students had great difficulty in determining the types of functions in the pretest. With no completely correct responses in the pretest, most of the students were unable to make sense of constant functions and unit functions. They used them interchangeably, and they generally used the concepts of composite function or entire function in determining the types of functions. In addition, the students showed the functions with cluster mapping and could not draw the graphs of the given functions in the pretest. Posttest data of the types of functions questions showed that the number of responses in the category of completely correct increased. Although the students were not able to determine the types of functions in these questions, they were able to draw the function graphs.

Regarding pretest operations in functions, combination of functions, and inverse of functions questions, the students attempted to perform operations without determining the definition and value sets of functions in composite functions and to perform the four operations in functions. Moreover, the students responded to the questions about the sum of functions incorrectly by composing. The posttest data showed that the students were able to determine the definition and value sets of functions and to do the four operations in functions, but they had difficulty with the questions about the composite process.

More than half of the student responses to the questions which asked about the drawings of the function graphs in the pretest were categorized as incorrect and unanswered. The students did not appear to know that function graphs can only consist of sequential pairs. They created a line by combining the dots, whereas they should not connect them in the graph. In addition, they thought the function had to be bound by an algebraic rule. Thus, they answered the questions of function graphs incorrectly. The students used proportional information instead of using the definition of linear functions in the pretest questions. They answered the questions incorrectly because they defined the starting point with inaccurate reasoning. The students were able to find the inverse of the functions given by algebraic expression, but could not draw the inverse of the functions given in the graph and could not deduce that the graphs of the function and of its inverse were symmetrical according to the line $y = x$. The posttest data revealed that the student response categories were higher than those in the pretest data. There was a significant increase in responses categorized as completely correct, and the students achieved the learning outcomes for function graphs.

In a study conducted by Clement (2001), very few students were able to determine the definition of function. In a study by Clement (2001), very few students were able to define functions. In Clement's (2001) study, the students combined the points with a line to create a graph of a group of points (ordered pairs). With this finding, it was revealed that the students saw the graphs of the functions as a line and thought that the functions should always be continuous. It can be said that the results of Clement's (2001) study are in parallel with the results obtained from the pretest data of this study. Because, as revealed in this study (eg, see question 10), Clement (2001) stated in his study that this was due to the fact that the students did not know the formal definition of a function. Another study was done by Karataş and Güven (2003). Karataş and Güven (2003) stated that high school students and prospective teachers could not connect between different representations of functions and failed to determine whether the expressions given were function or not. Similar results were obtained in the pretest data of this study (eg, see questions 1, 2, and 6).

It was observed that the students, who did not have sufficient knowledge for the definition of a function, types of functions, the inverse of functions, operations with functions and function graphs before the implementation, tried to employ mathematical competencies such as association, reasoning, and questioning following the implementation. There is information in the literature that the ability to use graphics is necessary and useful (Argun et al., 2014) in order to realize the relations between concepts and to model the problem situation while solving problems. The findings of the current study confirm this information.

In other words, graphs are a communication used to express information in different ways, and a teaching tool that contributes to the in-depth learning of concepts (Monk, 2003, as cited by Tekin & et al., 2009), as well as convenience and comprehensibility in data organization, summary, interpretation and presentation. (Taşar, İngeç, & Güneş, 2006). In this study in which scenarios are taught, it can be considered in problem situations arising from the handling of real life problems that students create the rule of function, show the types of functions with graphics, determine whether there is a function by plotting a given algebraic expression, and determine whether a given graph is a function.

In this research, when the pretest and posttest data were analyzed as a whole, the student responses progressed from the categories of incorrect and unanswered in the pretest to the categories of completely correct and partially correct in the posttest. This data suggests that instruction with scenarios related to daily life can promote students' mathematics achievement in the topic of functions.

5.3. Impact of Instruction with Scenarios on the Students' Views

Views on the method employed for teaching the topic of functions and function graphs were also collected from the students participating in this study. The findings obtained by content analysis of the students' views supported the findings regarding the quantitative data analysis. The analysis results revealed that there was a significant difference between the pretest and posttest FAT scores, and the difference was in favor of the posttest scores. Thus, the students mostly expressed positive views about the implementation. For instance, the number of students stating that instruction with scenarios was enjoyable, that it made understanding the topic easier, that it was useful for revealing thoughts, that it helped especially the topic of functions to be understood better, and that it made realizing and using mathematics in real life situations easier was quite high. In contrast, the students expressing negative views stated that they had difficulty early in the implementation since this was their first encounter with such an application. The results of the current study and the results of the study carried out by Çağırgan-Gülten et al. (2009) are compatible. Çağırgan-Gülten et al. (2009) stated that high school students do not have enough knowledge about the use of mathematics topics in daily life and the majority of them are not given daily life-related examples in their lessons. They also expressed that if daily life related situations are given in lessons, the students can learn easily and better.

5.4. Implications

The topic of functions has its own difficulties and inclusion of different representations is one of the reasons that students experience difficulties with this topic. Since function and function graphs are concepts that have real-world application areas, like most mathematical concepts, it is suggested that students be given examples that they can associate with daily life, that teaching be supported with real-life related scenarios, and that problems that require the use of the concept of function are appropriate for the structure of the topic.

By preparing scenarios suitable for other topics of mathematics and by using this teaching method at every grade level in secondary school, the effects on students' achievement levels in mathematics courses can be examined and comparisons can be made in various categories.

In this field, it was deemed appropriate to carry out the current research within the frame of developing the importance of analyzing functional thinking, that is, the relationship between changing quantities with mathematical words, symbols, tables, or graphic representations (Blaton et al., 2011. as cited by Uygur-Kabael, 2017). Finally, the small sample size of the research can be perceived as a limitation. However, the fact that the qualitative aspect of the research is predominant and the thought that it cannot be generalized to a larger sample group may decrease this limitation to a certain extent. Similar studies carried out in the future with more sample groups will give more enlightening results when the impact of teaching the topic of functions by associating with real life on students' mathematics achievement is investigated. This research can be repeated by using a quasi-experimental pattern with pretest-posttest control groups. With the acquisition of qualitative data the results can be presented in detail.

6. Conflict of Interest

The authors declare that there is no conflict of interest.

7. Ethics Committee Approval

The authors confirm that the study does not need ethics committee approval according to the research integrity rules in their country.

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