Vol. 15(7), pp. 354-369, July, 2020
DOI: 10.5897/ERR2020.3962
Article Number: 2B0B25964223
ISSN: 1990-3839
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Educational Research and Reviews

Full Length Research Paper

Impact of teaching topics of equality and equation with scenarios on 7th graders' mathematical achievement and mathematical motivation

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Received 22 March, 2020; Accepted 10 June, 2020

In the current study, effects of teaching equality and equation with scenarios on students' mathematical achievement and mathematical motivation were analyzed. In addition, students' views on using scenarios for teaching equality and equation were included. A pre-posttest quasi-experimental design with Control Group (CG) was employed as the design of the research. The study group of the current research consisted of sixty 7th graders studying at a secondary school located in a province of the Western Black Sea Region in Turkey. Mann Whitney U test and Wilcoxon signed rank test–nonparametric tests were employed for data analysis. When findings of the research were analyzed, it was found that there was a significant difference in mathematics achievement of the students in the Experimental Group (EG) on whom the scenario-based instructional approach was conducted compared to the students in the CG. It was found in this study that scenario-based instructional approach did not have a significant effect on mathematical motivations of the EG and CG students. In addition, correlation analysis conducted between Mathematics Achievement Test (MAT) and Mathematical Motivation Scale (MMS) scores showed that there were not any significant differences between the scores received from both tests by the EG and CG students.

Key words: Mathematical achievement, mathematical motivation, teaching with scenarios, equality, equation, secondary school students.

INTRODUCTION

In this world where change and development are constant, creative and entrepreneurial individuals who are able to perceive innovations and developments and to use them by creating new knowledge are required. As Glasser (1993) expressed, a 21st century individual ought to be the one who creates knowledge instead of storing it. Accordingly, the most important task is on schools to help individuals gain these characteristics. Today, the most

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significant task of schools is raising individuals who learn to learn and to think (Özden, 2013). When it is regarded as the first step to know how an individual learns and constructs knowledge in his/her mind, creating appropriate learning environments is the second step. Studies conducted in cognitive field revealed that students participating in learning process actively learn better (Harris et al., 2001). Thus, students ought to be taught the source of knowledge, how to reach this knowledge, how to evaluate it and how to use it for solving the problem (Van Til et al., 1997).

According to Özden (2013), learning is as personal as fingerprint. Therefore, each student has a different learning style, speed and capacity. Hence, students can do more than they know when they are provided suitable learning environments. In this context, student-centered learning settings in which individual differences are regarded and speaking and discussion opportunities are given ought to be preferred rather than teacher-centered learning settings in which there is a one-way information flow (Lampert, 1989 as cited by Brown et al., 1989). Scenario-based learning is also described as one of the student-centered methods that fosters active learning (Cerrah-Özsevgeç and Kocadağ, 2014). Scenario-based learning method means using scenarios to reveal target learning and instructional scenarios are used in this method to achieve certain educational aims (Errington, 2003; 2010).

In scenario-based learning, students are given the opportunity to think a problem over, to put what they have learnt into practice, to realize their lack of knowledge and to investigate ways of eliminating this. Students working on scenarios apply several higher-order thinking skills such as analyzing, synthesizing, evaluating and deciding (Açıkgöz, 2014). In the studies, in which this method is used, it is tried to teach students how to behave and to think like an expert in efficient learning settings, and they are encouraged to practice knowledge and skills they have obtained in environments that are created in a realistic and safe way (Schank and Weis, 2000). According to Özden (2013), things that are learned ought to go beyond classroom walls. For making things that are learned meaningful in real life, school subjects need to be connected to real life, and value of things learned by students need to be expressed. If students can apply what they learned in solving real life problems, it means that learning has gone beyond walls of the classroom. Scenario-based learning method (SBLM) is a method focusing on students by using real life problems and situations to promote students' learning. In this method, studies are generally conducted through small group discussions, and solution offers regarding the problem are obtained by discussing (Chen, 2008).

Scenario-based instructional approach was used in the following studies: Kocadağ (2010) used it for eliminating students' misconceptions and lacks of knowledge; Yaman (2005) used it for analyzing possible impact of it on students' reading comprehension skills, and Alptekin (2012) used it for determining effects of it on social skills of the students with mental disabilities. In other studies, Ersoy and Başer (2011) revealed that instruction with scenarios improved sustainability of learning of pre-service teachers; Haynes et al. (2009) concluded that scenario-based instructional approach helped students' understanding of the whole problem, their building a connection with real life and their multi-dimensional thinking; additionally, Siddiqui et al. (2008) found that this method developed students' achievement. While mathematics is one of the courses that makes most students' life miserable, it is regarded as a way of understanding and loving life for some (Sertöz, 2002). The most efficient science for mental and intellectual development is mathematics. However, low achievement in this course is a known fact. Within this context, methods used in mathematics course and teacher behaviors are regarded among reasons of failure in this course (Akın and Cancan, 2007).

The fact that students' mathematics achievement levels have been low has prompted educators both in Turkey and in the world to investigate factors affecting student achievement (Kiamanesh, 2004; Papanastasiou, 2000; Wang, 2004; Yayan and Berberoğlu, 2004). Reasons of students' academic failure have been expressed as follows: *Teacher behaviors, teaching methods, lack of study, problems about learning environment, content of the subject (instructional programs), students' psychological problems, dissatisfaction in family, effect of department being studied on career and work life and problems about using time* (Aysan et al., 1996, as cited by Çetin and Bulut, 2014). Therefore, scenario-based instructional approach which fosters active learning in increasing mathematics achievement is regarded to be efficient. Students' affective features such as interest, attitude, anxiety, motivation, self, personality and value judgment are as significant as their cognitive features in learning and teaching mathematics (Uluçay and Güven, 2017). One of the important factors in enabling and developing sustainability of student achievement is student motivation (Orhan-Özen, 2017, Robinson, 2017, as cited by Sürücü and Ünal (2018). Student motivation is a basic element necessary for quality education. Motivation is generally described as the degree of an individual's taking action and of continuity in his/her goal-oriented attempts (Adler et al., 2001). Williams and Williams (2011) explained the factors affecting student motivation as student, teacher, content, method-process and learning setting. Method and process which is a way of presenting mathematical content ought to promote student motivation. In addition, environments in which situations based on students' real-life experiences are applied, students are academically productive and critical thinking is supported should be created (Mueller et al., 2011; Williams and Williams, 2011).

In general, students tend to learn topics they are

interested in faster, and they succeed as long as they are motivated (Akbaba, 2006). Students' active participation in learning process raises their motivation, and their participation in decision-making affects their value systems, mental structures and motivations positively (Baltaş, 2002, as cited by Akbaba (2006). When it is considered that there is a positive and significant relationship between motivation and achievement (Akbaba, 2006; Herges et al., 2017; Moenikia and Zahed-Babelon, 2010), it becomes crucial to provide student motivation towards mathematics in the process of learning mathematics. In this context, mathematical motivation is described as being eager to learn mathematics and taking part in mathematical activities actively (İspir et al., 2011). Martin (2001) defined motivation as a driving force for students to be successful, to work hard at school and to learn (Yaman and Dede, 2007). This reveals that motivation affects learning considerably (Glynn et al., 2005; Lumsden, 1994; Martin, 2001). Motivated students are careful, start to work on their tasks, ask questions, give answers voluntarily and seem to be happy and eager (Palmer, 2007). For understanding students' behaviors in the classroom, knowledge and tendency of teachers/educators about what motivation is and how it is organized are needed to be increased (Hannula, 2006). That is because of the fact that students have cognitive and upper cognitive difficulties while learning mathematics, and they tend to have negative feelings that prevent their efforts and to have weak motivation (Kramarski et al., 2010; Tzohar-Rozen and Kramarski, 2014). Teachers' duty is not only knowing what makes students motivated, but also helping them raise and develop their motivational levels and preparing motivational situations. Thusi teachers' effort for this can be a beginning to lead a quality conceptual learning for students (Rifandi, 2013). If teachers design an effective learning instrument for students and use in-class activities with appropriate strategies and methods, students' interests in learning will rise (Rifandi, 2013). In general; however, affective factor is neglected in educational studies, and cognitive factor is given more prominence (Seah and Bishop, 2000; Tuan et al., 2005).

In the relevant literature, conclusions of studies on learning mathematics and on mathematical motivation are often positive. Waege (2010) described motivation as a potential to direct a behavior. This potential is constructed through student's needs and goals. In this context, Waege (2010) suggested a theoretical frame in which primary and secondary school students' motivations in the course of mathematics were analyzed. Accordingly, he stated in his study that students are impressed by changes in instructional approaches although they have motivation to learn, and that their mathematical motivation improved in a short time. At this point, what important is conducting studies that fulfill students' learning goals with activities, methods and techniques which would trigger their needs to learn. In their study in which they analyzed high school students' motivations of mathematics learning via survey and interview, Fuqoha et al. (2018) found that their motivations were high. Additionally, students expressed during interviews conducted with them that a fun and enjoyable learning environment, in which there are some technological materials that have certain features, which teaches not to give up easily and where there are difficulties, increased their motivations towards learning mathematics. Abramovich et al. (2019) claimed that when mathematics courses are conducted with daily life practices arousing students' curiosity, it becomes possible that motivations of students from all levels towards mathematics course can improve. Thus, it has a great potential for student achievement. The other studies on mathematics course and mathematical motivation were generally about impact of pre-service teachers' technology use on their motivations towards learning mathematics (Halat and Peker, 2011), relationship among secondary school students' motivations and their mathematics achievements, mathematical attitudes, academic motivations and intelligence quotients (Moenikia and Zahed-Babelon, 2010), their academic achievements, classroom levels, parents' educational backgrounds (Uluçay and Güven, 2017), impact of solving mathematical verbal problems through individual instruction on motivation (Awofala, 2016), relationship between metacognition and motivation in mathematics learning (Karaali, 2015), impact of perceptions regarding mathematics achievement on motivational attitudes (Middleton and Spanias, 1999), correlation between intrinsic and extrinsic motivation (Dede and Argün, 2004). Herges, Duffueld et al. (2017) concluded in their study conducted with secondary school students that there was a strong positive correlation between intrinsic motivation and achievement, yet extrinsic motivation had a mediocre effect size. Accordingly, students' confidence in mathematics and its practicability caused them to enjoy mathematics, and thus to become successful. Equation has been one of the significant mathematical structures used as a tool to make several measurements and calculations in daily life since the ancient times. Any open condition including equality relation is described as an equation. Lexical meaning of equation is "equality, equation provided only when a suitable value is given to some quantities included in it" (Argün et al., 2014).

In Turkey, topics of equality and equation were involved in sub-learning area of equality and equation in learning domain of algebra in Mathematics Course Curriculum for Secondary Schools (MoNE, 2018) Equations help students solve their daily problems more systematically and orderly. Besides, they give them the opportunity to solve problems of mathematics (Köroğlu et al., 2004). There are several studies about equality and equation in Turkey and in the world. Studies were generally

conducted with secondary school students (Ceylan, 2014; Çakmak-Gürel and Okur, 2017; Eski, 2011; Tekay and Doğan, 2015; Işıtan and Doğan, 2011; Nas, 2008; Zengin, 2019), high school students (Yahya and Shahrill, 2015), pre-service mathematics teachers (Sert-Çelik, 2018) and mathematics teachers (Attorps, 2004). As conclusions of these studies are important for evaluating results of the current study, they are given with their results. Tekay and Doğan (2015) expressed that the 7th graders had difficulty in solving questions related to graphics of linear equations. Furthermore, Işıtan and Doğan (2011) concluded that 8th graders often had weak equating skills, and they solved the questions where equations were given in advance with random arithmetic operations. Nas (2008) stated that 6th graders' using computer software in learning a topic contributed to their achievement, and that students in the EG had less misconceptions; Zengin (2019) found that computer-aided instruction influenced 7th graders' achievement positively; Ceylan (2014) revealed that drama reduced 6th graders' anxieties towards mathematics, increased their love and interest and helped them have positive attitude towards it. While Yahya and Shahrill (2015) found that 11th graders had some difficulties about second-degree equations, Çakmak-Gürel and Okur (2015) indicated that the 7th graders had more misconceptions compared to the 8th graders. Sert-Çelik (2018) stated that 7th graders had misconceptions about equality and equation and understanding difficulties, and their teachers were aware of these difficulties, yet they expressed superficial reasons regarding this. Eski (2011) implemented the approach of problem-based learning in teaching 7th graders the topic of equality and equation. He claimed as a result of the implementation that there were not any significant differences between the EG and CG; however, students' participation in mathematics lessons increased positively.

One of the reasons that most students do not understand equality and equation is that they regard it as out of real life and do not associate it with real life (Dede, 2005). It can be seen in the literature that students have difficulties in equating and solving equations and they often make common mistakes (Akkan et al., 2009; Dede and Peker, 2007). A study about equations with one unknown was carried out on high school first grade students by Erbaş et al. (2009). It was revealed in this study that students made various mistakes on arithmetic mistakes, concept of equality, substitution and unidentified arithmetic mistakes. The fact that students had fallacies on division of both sides of equality to coefficient of an unknown makes us think that they do not quite understand the concept of equality. It was understood that the rule of gathering the knowns in one side and the unknowns in the other side for solving equation was misunderstood. On the other side, meaning students assigned to the equals sign has been a subject of several studies. Generally, students regard the equals sign as "do the operation and find the result" rather than an equality indicator between expressions in right and left sides. Another fallacy is that they regard it as a sign on right of which result of equality is written (Oktaç, 2010). Therefore, the concept of equality ought to be constructed well to understand equations. Comprehending meaning of the equals sign has a critical significance in terms of creation of mathematical thinking and of thinking about mathematical relations (Carpenter et al., 2005). The logic of equality and writing equality should be taught before teaching the concept of equation (Altun, 2014). The studies conducted have showed that students from all classroom levels have various difficulties regarding equality and equation.

In the explanations made, it was emphasized that students' individual characteristics, learning environments and especially their motivations had critical importance for mathematics achievement. Researchers/educators argue that learning settings need to be reorganized by giving up traditional understanding. Hence, using new methods such as scenario-based learning in mathematics teaching is important. Scenario-based learning method contributes to development of communicative and linguistic skills which are basic skills along with interaction and meaningful. Environments where instruction is carried out with scenario that promotes active learning give students the opportunity to take over learning responsibility and to learn effectively. In the current study, it is supposed that students can be motivated to learn mathematics and take part in the activities more eagerly and more efficiently in such learning settings. As explained above, motivated students are careful; they ask questions and give answers voluntarily. Moreover, they seem happy and eager. Therefore, impact of this method on students' mathematical motivations was investigated in the present study. It is believed that scenario-based learning method can be effective in raising students' mathematics achievement. In the relevant literature, two outweighing reasons of students' failure in mathematics course are teachers and methods used. No studies have been found about effect of teaching "equality and equation" with scenario-based learning method to 7th graders on their mathematics achievement and mathematical motivation. Therefore, it is suggested that the current study would remarkably contribute to the literature.

Aim of the research

In the current study, effects of teaching equality and equation with scenarios on students' mathematical achievement and mathematical motivation were analyzed. In addition, students' views on using scenarios for teaching equality and equation were included. Accordingly, answers for the following sub-problems were investigated:

1. Are there any statistically significant differences between MAT pre-test scores of the EG students on whom teaching was held with scenarios and of the CG students on whom current instructional program was employed?
2. Are there any statistically significant differences between MAT post-test scores of the EG students on whom teaching was held with scenarios and of the CG students on whom current instructional program was employed?
3. Are there any statistically significant differences between motivation pre-test scores of the EG students on whom teaching was held with scenarios and of the CG students on whom current instructional program was employed?
4. Are there any statistically significant differences between motivation post-test scores of the EG students on whom teaching was held with scenarios and of the CG students on whom current instructional program was employed?
5. Are there any statistically significant differences between MAT pre-test and post-test scores of the CG students on whom current instructional program was employed?
6. Are there any statistically significant differences between MAT pre-test and post-test scores of the EG students on whom teaching was held with scenarios?
7. Are there any significant correlations between the scores the EG and CG students received from the MMS and the scores they received from MAT?
8. What are the EG students' views on teaching equality and equation with scenarios?

METHODOLOGY

Research design

In the current study, experimental method-one of the quantitavie research methods–was employed in the phase of problem evaluation. A pret-posttest quasi-experimental design with control group was employed as the design of the research (Büyüköztürk et al., 2013). The findings obtained through quantitative data analysis were supported with qualitative data. 2×2 mixed design was employed to evaluate quantitative data of the research. The mixed design was preferred since measurements were conducted both within (pre-posttest) and between groups (experimental-control). Mathematics achievements and mathematical motivations of the groups were gauged twice using the same tools before and after the implementation. A case study based on qualitative research approach was employed in qualitative data analysis (McMillian and Schumacher, 2010). The data obtained from the EG students' views on scenario-based learning method were analyzed by content analysis-one of qualitative data analysis techniques (Yıldırım and Şimşek, 2008). Table 1 give pretest and posttest measurement of the EG and CG.

The study group

The study group of the current research consisted of sixty 7^{th} graders (23 girls and 37 boys) studying at a secondary school located in a province of the Western Black Sea Region in Turkey. One of the two classes which were equal was randomly selected as the EG, while the other was selected as the CG. There were 30 students, 12 of whom were girls and 18 of whom were boys in the EG, and there were 30 students, 11 of whom were girls and 19 of whom were boys in the CG. Scenarios about equality and equation were implemented by the researchers and the teacher of the lesson during 20 class hours. At the end of the implementation, the students were asked to write their opinions about usage of scenarios. Codes such as S1, S2, … were used instead of the students' real names.

Data collection tools

Equivalency test (ET), mathematics achievement test (MAT), mathematical motivation scale (MMS), semi-structured student interview form (SSSIF), and scenarios and activities to be used with the EG were employed as data collection tools.

The equivalency test (ET)

An equivalency test which contained 20 multiple-choice questions was prepared by the researchers to test equivalency of the groups by asking experts' opinions. The test was prepared in compliance with the learning outcomes required in 5^{th}, 6^{th} and 7^{th} grades in the Secondary School Mathematics Course Curriculum (2018). A pilot study was conducted with sixty 8^{th} grade students studying at a state school and a private school located in a province of the Western Black Sea Region in Turkey. As a result of the pilot study, item analysis was performed; distinctiveness and difficulty of the items were analyzed. Since the distinctiveness level was found above 0.20, the 20 question-test was not edited and used as the equivalency test. Cronbach's Alpha reliability coefficient of the test was found as 0.873. One of the two groups between which there were not any statistically significant differences was selected as the EG, and the other was assigned as the CG by lot. As the distribution was normal, the EG and CG were regarded as equal to each other since there were not any statistically significant differences between the groups as a result of independent samples t-test.

Mathematics achievement test (MAT)

Learning outcomes and concepts regarding equality and equation learning domain in Secondary School Mathematics Course Curriculum (MoNE, 2013, 2017) were examined to prepare MAT. The items included in the test were prepared by benefitting from Secondary School Mathematics Course Curriculum (MoNE, 2013, 2017), mathematics teaching books (Altun, 2014; Baykul, 2014; Van de Walle et al., 2013) and relevant literature. A test consisting of 25 items were prepared in a way to cover all learning outcomes of the topic of equality and equation. A pilot study was carried out with sixty 8^{th} graders studying in the same region to provide validity and reliability. As a result of the pilot study, two items were removed from the test as their distinctiveness levels were below 0.20. Cronbach's Alpha reliability coefficient of the final form of the MAT containing 23 items was found as 0.704.

Mathematical motivation scale (MMS)

In the current study, "Scale of Motivation towards Mathematics Course", which was developed by Üzel et al. (2018) and whose Cronbach's Alpha reliability coefficient was 0.88 was employed in order to gauge students' motivations towards mathematics course.

Table 1. Experimental design of the research.

	Pretest			Posttest	
	MAT	**MMS**	**Operation**	**MAT**	**MMS**
EG	O_1	O_3	Implementation with scenario-based instruction	O_7	O_5
CG	O_2	O_4	Implementation with current instructional method	O_8	O_6

The scale consisted of 26 items 18 of which were positive and the other 8 of which were negative. The highest score to be received from the scale was 98, and the lowest score to be received was 58. A high score to be received from the scale would mean that students had high motivation towards mathematics course. The scale was implemented twice in both groups before and after the implementation.

Semi-structured interview form (SSIF) and scenarios-activities

Qualitative data of the research were obtained through a semi-structured interview form including 10 questions to get students' opinions about the implementation. The students were asked to write their thoughts for the questions. Following implementation of the form, 10 students were randomly selected, and an interview was made with each of them. The researchers created codes by looking at students' responses, and content analysis was performed. Scenarios about equality and equation were prepared by the researchers by asking experts' opinions. Five scenarios and five activities for each learning outcome, explained in equality and equation learning domain of Secondary School Mathematics Course Curriculum (2018) as able to comprehend conservation of equality, to recognize a first-degree equation with one unknown and to equate and to solve a first-degree equation with one unknown for the real life situations given and to solve problems that require to equate a first-degree equation with one, were created.

The process of experimental study

The EG in which scenario-based instruction was employed was divided into 5 heterogeneous groups each of which included 6 students. 30 students took part in the implementation in total. The classroom setting was reorganized in order to facilitate interaction of the group members and to help them study more comfortably. Before starting the lesson, the students had been informed about the method to be employed, and they explained what they were required to do by the researchers and the teacher during the implementation. The implementation of 20 hours of lessons was conducted for over two months. Five scenarios and five activities were used in the implementation with the EG. 4 students in the EG did not attend the classes regularly and did not participate in the posttests. Therefore, the data obtained from these students were not included in the analyses. On the other hand, current instructional program (MoNE, 2018) was employed in the classes in the CG.

Data analysis

The quantitative data of the current study were analyzed via SPSS 22.0 statistical package. As the data showed normal distribution, dependent samples t-test and independent samples t-test were conducted to reveal if the students' mathematics achievements differed with regard to the method employed. However, Mann Whitney U-test and Wilcoxon signed rank test-onparametric tests were performed to reveal if the students' mathematical motivations differed with regard to the method employed since the data were not distributed normally. Impact of scenario-based instruction on students' views was obtained through semi-structured interview form prepared by the researchers. The data obtained from views of the students in the EG on scenario-based instructional approach were analyzed via content analysis (Yıldırım and Şimşek, 2008). This method was employed as the 7th grade students' views on teaching equality and equation with scenarios were scrutinized. Apart from the students' written explanations in the forms, 10 students were interviewed.

RESULTS

Aim of the current research was to reveal possible impact of using scenario-based instructional approach to teach 7th graders equality and equation on students' mathematics achievement and on their mathematical motivation. The research was conducted with 56 students 26 of whom were assigned to the EG and 30 of whom were assigned to the CG in a state school located in Western Black Sea Region of Turkey. The scenario-based instructional approach was employed in the EG, and current instructional method was implemented without any intervention. The study was carried out according to a pretest-posttest CG design. Some results were obtained through statistical analyses of the data. These results were examined in three sections.

One of the sub-problems of the current research was investigating if teaching with scenarios affected students' mathematics achievement. When findings of the research were analyzed, it was found that there was a significant difference in mathematics achievement of the students in the EG on whom the scenario-based instructional approach was conducted compared to the students in the CG. This finding showed that teaching with scenarios was effective in increasing students' mathematics achievement. Scenario-based instruction encourages students to participate actively in the learning process and to take over responsibility of their own learning.

The second sub-problem of the study was analyzing impact of teaching with scenarios on students' mathematical motivation. It was found in this study that scenario-based instructional approach did not have a significant effect on mathematical motivations of the EG and CG students. In addition, correlation analysis conducted between MAT and MMS scores showed that there were not any significant differences between the scores received from both tests by the EG and CG students. When these two results are taken into account, it is understood that factors affecting students'

mathematical motivation ought to be investigated in further studies. However, impressions caught from the EG and qualitative analyses regarding EG students' views on the study made us think that positive interpretations about scenario-based instructional approach can be made. That is because most of the students in the EG expressed positive opinions about the method employed. The students expressed that with the method used, the lessons became funnier, more enjoyable, more instructive and clearer; learning got more permanent; their problem-solving skills got improved and teaching by associating topic with daily life via scenarios made their learning easier. Furthermore, students stated that their interests and motivations towards the course improved, and they attended lessons willingly although there were not any statistically significant differences between the groups regarding their scores MMS. When within-group mathematics achievements of both groups were evaluated, a statistically significant difference was found, but a significant difference was observed in favor of the EG as a result of between-groups analyses of mathematics achievement. Contrarily, when analyses with regard to the scores received from MMS by both groups were scrutinized, there were not any statistically significant differences between the groups.

Results of the ET

T-test results regarding the scores that the EG and CG students received from the ET are given in Table 2.

The ET mean score of the students in the EG was found ($\overline{X}_{EG}$=60.00), while the ET mean score of the ones in the CG was found ($\overline{X}_{CG}$=54.26) before any intervention. No significant difference was observed between the scores received from the ET by the students in the EG and CG as a result of the independent samples t-test performed $\left[t_{(54)} = 1.00, p > .05\right]$. This ensured that the EG and the CG were equal to each other before the intervention.

Comparison of MAT pretest scores of the EG and CG

The first sub-problem of the research was "Are there any statistically significant differences between MAT pre-test scores of the EG students on whom teaching was held with scenarios and of the CG students on whom current instructional program was employed?" For the solution of this problem, independent samples t-test was employed to reveal if there were any significant differences between the scores that the students in the EG and in the CG received from MAT pretest. Finding regarding this problem was presented in Table 3.

It can be seen in Table 3 that there were not any significant differences between the EG and CG students regarding the pretest scores that they received from MAT $\left[t_{(54)} = 1.90, p > .05\right]$.

Comparison of MAT posttest scores of the EG and CG

The second sub-problem of the research was "Are there any statistically significant differences between mathematics achievement post-test scores of the EG students on whom teaching was held with scenarios and of the CG students on whom current instructional program was employed?" Independent samples t-test was employed to reveal if there were any significant differences between the scores that the students in the EG and in the CG received from MAT posttest. Finding regarding this problem was presented in Table 4.

Following the implementation of scenario-based instruction in the EG and of current instructional program in the CG, it was seen that MAT posttest mean scores of the EG students ($\overline{X}_{EG}$=19.50) were higher than their pretest mean scores ($\overline{X}_{EG}$=9.67), and MAT posttest mean scores of the CG students ($\overline{X}_{CG}$=12.93) were higher than their pretest mean scores ($\overline{X}_{CG}$=11.96), thus the increase in the EG was higher. In Table 3, it is clear that a significant difference was found between MAT posttest scores of the two groups as a result of independent samples t-test conducted for posttest scores of the EG and CG students $\left[t_{(54)} = 5.17, p < .05\right]$. In this context, it was understood that MAT of the EG students was more than of the CG students. This situation revealed that scenario-based instructional approach was effective on mathematics achievement.

U-test results regarding MMS pretest scores by groups

The third sub-problem of the research was "Are there any statistically significant differences between motivation pre-test scores of the EG students on whom teaching was held with scenarios and of the CG students on whom current instructional program was employed?". Mann Whitney U-test was employed to reveal if there were any significant differences between the scores that the students in the EG and in the CG received from MMS before the intervention. Finding regarding this problem was given in Table 5.

It was understood from Table 5 that there were not any significant differences between MMS pretest scores of the EG and CG (U=319.000, p>0.05).

U-test results regarding mms posttest scores by groups

The fourth sub-problem of the research was "Are there any statistically significant differences between motivation

Table 2. t-test results regarding ET Scores of the EG and CG.

Group	N	$\bar{X}$	sd	t	p
EG	26	60.00	20.18	-1.00	.320
CG	30	54.26	18.48		

Table 3. t-test results regarding MAT pretest by groups.

Groups	N	$\bar{X}$	sd	t	p
EG	26	9.67	5.390	1.903	.062
CG	30	11.96	3.168		

Table 4. t-test results regarding MAT posttest by groups.

Groups	N	$\bar{X}$	sd	t	p
EG	26	19.50	3.723	5.172	0.000
CG	30	12.93	5.464		

Table 5. U-test results regarding mms pretest scores by groups.

Groups	N	Mean rank	Rank sum	U	p
EG	26	25.77	670.00	319.000	.243
CG	30	30.87	926.00		

Table 6. U-test results regarding MMS posttest scores by groups.

Group	N	Mean rank	Rank sum	U	p
EG	26	28.21	733.50	382.500	0.902
CG	30	28.75	862.50		

post-test scores of the EG students on whom teaching was held with scenarios and of the CG students on whom current instructional program was employed?". Finding revealing if there was a significant difference between MMS posttest scores of the EG and CG students based on the methods implemented was presented in Table 6.

Mann Whitney U-test results regarding MMS posttest scores of the students in the EG and CG were given in Table 6. Accordingly, there were not any significant differences between the MMS scores of the students on whom scenario-based instruction was conducted and of the ones on whom current instructional method was implemented (U=382.500, p>0.05).

Dependent samples t-test results regarding MAT pretest and posttest scores of the CG students

The fifth sub-problem of the research was "Are there any statistically significant differences between MAT pre-test and post-test scores of the CG students on whom current instructional program was employed?". Dependent samples t-test results with regard to MAT pretest and posttest scores of the CG students were given in Table 7.

It was seen that posttest scores that the CG students received from MAT ($\bar{X}_{CG}$ =12.93) were higher than their pretest scores ($\bar{X}_{CG}$ =9.67). At the end of the intervention, a significant difference was found between MAT pretest and posttest scores of the CG students. This finding showed that students' mathematics achievement improved when current instructional program was conducted efficiently.

Dependent samples t-test results regarding MAT pretest and posttest scores of the EG students

The sixth sub-problem of the research was "Are there any statistically significant differences between MAT pre-test

Table 7. Comparison of MAT pretest and posttest scores of the CG.

Tests	N	$\bar{X}$	sd	t	p
MAT-pretest	30	9.67	5.390	-2.710	0.011
MAT-posttest		12.93	5.464		

Table 8. Comparison of MAT pretest-posttest scores of the EG.

Tests	N	$\bar{X}$	sd	t	p
MAT-pretest	26	11.96	3.168	-8.118	0.000
MAT-posttest		19.50	3.723		

Table 9. Wilcoxon signed rank test results regarding MMS pretest and posttest scores of CG.

Pretest - Posttest	N	Mean rank	Rank sum	z	p
Negative rank	9	14.38	133.00	1.828*	.068
Pozitive rank	20	15.10	302.00		
Equal	1	-	-		

*Based on positive ranks.

and post-test scores of the EG students on whom teaching was held with scenarios?" Dependent samples t-test results conducted to determine whether there was a significant difference between MAT pretest and posttest scores of the EG students were given in Table 8.

After implementation of MAT to the EG, it was observed that students' mathematics achievement posttest mean scores ($\bar{X}_{EG}$=19.50) were higher than their pretest scores ($\bar{X}_{EG}$ =11.96). It can be deduced from Table 8 that mathematics achievement mean scores of the EG were higher than of the CG. The results of the analysis revealed that there was a significant difference between before-intervention and after-intervention scores of the EG students. With reference to this finding, it can be suggested that scenario-based instructional approach had a significant effect on EG students' improvement of mathematics achievement.

Wilcoxon signed rank test results regarding MMS pretest and posttest scores of the CG students

Wilcoxon signed rank test was employed to reveal if there were any significant differences between the scores that the students in the CG received from MMS before and after the intervention. The results were given in Table 9. Table 9 indicated that there were not any significant differences between MMS pretest and posttest scores of the CG students (z=1.828; p>0.05).

Wilcoxon signed rank test results regarding MMS pretest and posttest scores of the EG students

Wilcoxon Signed Rank Test was employed to reveal if there were any significant differences between the scores that the students in the EG received from MMS before and after the intervention. The results were given in Table 10. In Table 10, it was seen that there were not any significant differences between MMS pretest and posttest scores of the EG students (z = 1.575, p >0.05).

Correlation analysis of the scores received from MAT and MMS

In Table 11, correlation analysis results with regard to the posttest scores received from MAT test and MMS by the EG and CG students. Accordingly, Spearman Brown Rank Correlation analysis (Can, 2013; Kalaycı, 2010) was used as the variables were dichotomously far away from normal distribution (Can, 2013; Kalaycı, 2010).

Spearman Brown Rank Correlation analysis was performed to test if there was a statistically significant difference between the students' MAT and MMS scores [r_d (26) = 0.023, p≥0.05; r_k (30) = -0.038, p ≥0.05]. On the basis of this result, it was concluded that there were not any significant differences between MAT and MMS scores of the EG and CG students.

The EG students' views on teaching with scenarios

Here, qualitative findings regarding the eighth sub problem of the research which was "What are the EG students' views on teaching equality and equation with scenarios?" were given.

In Table 12 and Figure 1, the EG students' views on teaching equality and equation with scenarios were

Table 10. Wilcoxon signed rank test results regarding MMS pretest and posttest scores of the EG.

Pretest – posttest	N	Mean rank	Rank sum	z	p
Negative rank	11	10.32	113.50	1.575*	0.115
Pozitive rank	15	15.83	237.50		
Equal	0	-	-		

*Based on positive ranks.

Table 11. Correlation analysis between MAT and MMS of the EG and CG.

	Correlation			MAT	MMS
EG	Spearman's rho	MAT	Correlation coefficient	1.000	0.023
			Sig (2-tailed)	0.0	0.912
			N	26	26
		MMS	Correlaiton coefficient	0.023	1.000
			Sig(2-tailed)	0.912	0.0
			N	26	26
CG	Spearman's rho	MAT	Correlation coefficient	1.000	-0.038
			Sig(2-tailed)	0.0	0.840
			N	30	30
		MMS	Correlation coefficient	-0.038	1.000
			Sig(2-tailed)	0.840	0.0
			N	30	30

p<.05, correlation is significant at the 0.05 level (2-tailed).

Table 12. Frequency and percentages regarding the EG students' views on teaching equality and equation with scenarios.

Category	Codes	f	%
Positive views	Teaching with scenarios and its contribution to learning the topic	26	36.11
	Design of scenarios and activities	9	12.50
	Its contribution to affective learning / socialization / group work	18	25
	Comparison of two methods	15	20.83
Negative views	Design of scenarios	1	1.38
	Group work	3	4.16
Sum		**72**	**100**

included. Figure 1 also shows the categories and sub-categories of student views. The students' views were categorized into codes of positive and negative views, and of "teaching with scenarios and its contribution to learning the topic", "design of scenarios", "its contribution to affective learning/socialization/group work", "comparison of the current instructional method and scenario-based instruction". Frequency and percentage distribution of each code were given in Table 12.

According to the Table 12, the most attractive positive views of the students 94% of whom had positive views were about teaching with scenarios, its contribution to permanent learning and comparison of scenario-based instruction and current instructional method. The students expressed that with the method used, the lessons became funnier, more enjoyable, more instructive and clearer; learning got more permanent; their problem-solving skills got improved, and teaching by associating

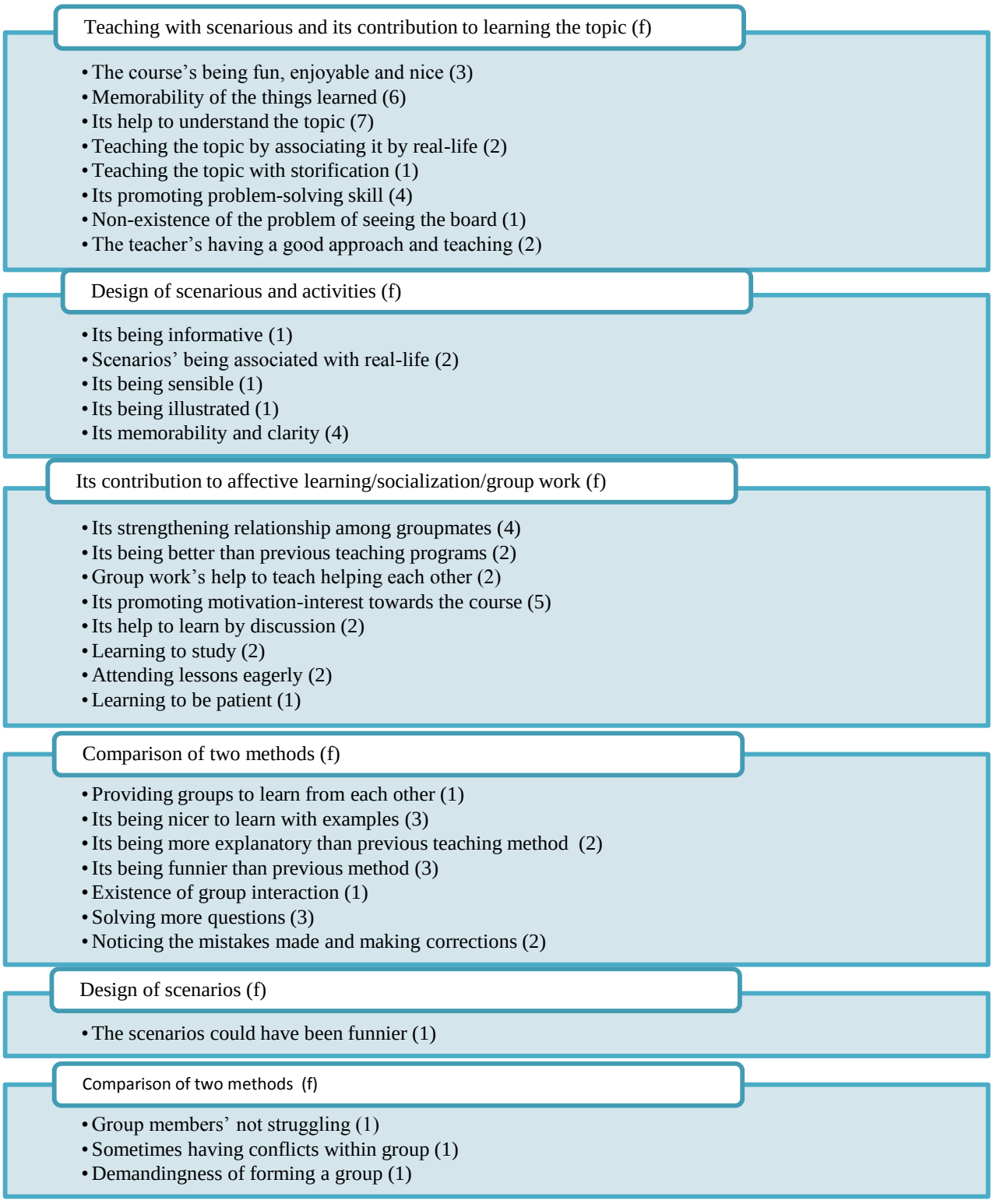


Figure 1. Categories, sub-categories and frequencies of student views.

and storifying topic with daily life via scenarios made their learning easier. Furthermore, the students who regarded the teacher's approach positive stated that they learned to be patient, attended the lessons more willingly, their interest and motivation towards the course increased, they learned to help each other within groups and their

I love this method because I can find correct answer by sharing my mistake. The method should be continued. Its benefits developed my problem-solving skill. **S6**	It's a good method. We can go on like this. It is funny and we can ask the group if we don't understand a question. Continuing the course in this was can be nice. **S11**

Figure 2. Positive views of S6 and S11 on teaching of the course with scenarios.

This kind of teaching is pretty good for me because we can understand anything that we cannot do better by discussing it with our groupmates. In my opinion, it is catchier in this way. Thus, let's go on our lessons in this way. **S10**

Figure 3. Positive views of S10 on teaching of the course with scenarios.

I liked and enjoyed it because I am able to understand the questions that I don't understand by discussion. It's better than our previous teaching program. It's more enjoyable, and I have started to attend lessons more willingly. **S3**	I think this teaching is very good because we've learned to work in groups, and I like it. However, it has some disadvantages such as discussions within groups. This is not nice, yet I like this kind of teaching. Let all our lessons be taught in this way. **S7**

Figure 4. Views of S3 and S7 on teaching of the course with scenarios.

Positive Sides
If lessons are taught in this way, it is better. We can learn to help each other, and lessons become better. We don't experience the problem of not seeing the board.
Negative Sides
In forepart of the classroom, students whose backs are facing the board have the problem of turning and of neck pain. **S19**

Figure 5. Views of S19 on teaching of the course with scenarios.

bond of friendsip developed with the help of this method. Examples of these views taken from S6, S10 and S11 were given in Figures 2 and Figure 3.

The students expressed that continuing use of this method would be better for them, learning was more enjoyable with this method, it provided convenience in understanding the topic, they were able to find the correct answers via group discussions, their knowledge became permanent and their problem-solving skills were developed with this method.

The students who thought that the scenario-based instruction was more advantageous than the current instructional method mentioned that especially learning with examples was better, learning through this method was more explanatory and permanent, it provided more opportunity for solving questions, groups could learn from each other via group interaction and they were able to notice and correct the mistakes they made. While students with negative views mostly expressed the problems about group work they experienced, one student suggested that scenarios could be prepared in a more enjoyable way. Examples of these views taken from S3, S7 and S19 were given in Figures 4 and 5.

S3, S7 and S19 expressed that instruction with scenarios was more fruitful compared to the current instructional method, and it would be better if teaching is carried on with scenarios. The views of the students with their own handwriting are given in Annex 1.

DISCUSSION

Scenario-based instruction encourages students to participate actively in the learning process and to take over responsibility of their own learning. The studies conducted revealed that students who actively participate in learning process learn better (Harris et al., 2001; Cantürk-Günhan, 2006). This is because of the fact that in scenario-based instruction, students are taught how to use their knowledge to solve a problem (Van till et al.,

1997; Vaughan and Garrison, 2008), and they are given the opportunity to talk and to discuss freely (Lampert, 1989, as cited by Brown et al., 1989). Students are aware of what and how they do in teaching with scenarios (Cerrah-Özsevgeç and Kocadağ, 2014). In this context, results of several studies in which scenario-based instruction was employed (Ersoy and Başer, 2011; Haynes et al., 2009; Özsoy et al., 2007; Siddiqui et al., 2008) are consistent with the results of the present study. Ersoy and Başer (2011) expressed in their study which was conducted with pre-service teachers that teaching with scenarios increased permanence of learning; Haynes et al. (2009) claimed that it helped understanding a problem as a whole, associating it with real life and thinking multidimensionally; Siddiqui et al. (2008) suggested that it fostered student achievement. Özsoy et al. (2007) used scenarios in teaching "special triangle" to secondary school and high school students. Pre-service teachers who supported this study stated that two of the factors affecting students' academic achievement were problems about teaching methods and learning environment (Aysan et al., 1996, as cited by Çetin and Bulut, 2014). In the present study, teaching with scenarios which is a different instructional approach was employed, and it was revealed that this approach was effective in improving students' mathematics achievement.

The result of the current study conflicts with the studies in which student motivation in mathematics course was examined (Abramovich et al., 2019; Awofala, 2016; Fuqoha et al., 2018; Halat and Peker, 2011; Waege, 2010), however, in a study conducted with 7th grade students by Dede (2003), no significant differences were found between mathematical motivations of the EG and CG. Therefore, results of the current study are compatible with the results of the study carried out by Dede (2003).

Another problem of the current study was to reveal if there was a significant difference between mathematics achievement and mathematical motivation. Correlation analysis made between MAT and MMS scores showed that there were not any significant differences between the scores received from both tests by the EG and CG students. The results of the current study are inconsistent with the studies suggesting that students' perceptions of mathematics achievement influenced their motivational attitudes (Middleton and Spanias, 1999) and that there was a strong positive relationship between intrinsic motivation and achievement, yet extrinsic motivation had mediocre impact (Herges et al., 2017).

Several implications can be suggested from this study. It is a known fact that motivation is of great importance for academic achievement. However, it was concluded in this study that scenario-based instructional approach was not effective on improvement of mathematical motivation, while it was effective on increasing mathematics achievement. In this context, it can be suggested that factors affecting mathematical motivation should be scrutinized with qualitative data in further studies. This study is limited to a total of 56 7th grade students in the Experimental and Control Groups, equality and equation topics and 20 h of lessons conducted for over two months.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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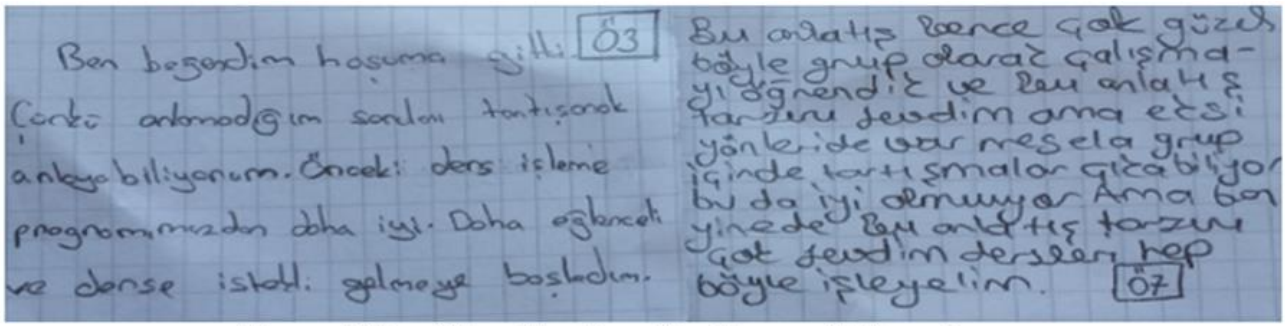
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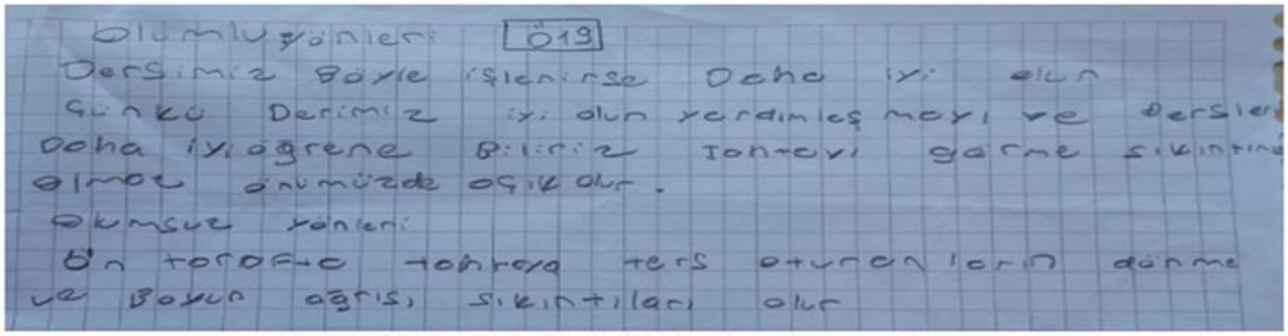
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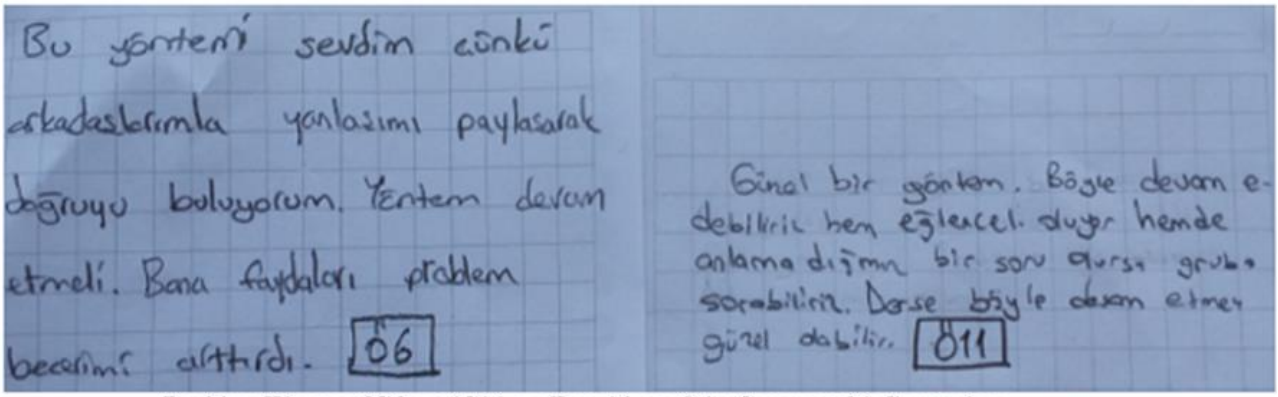
Annex 1



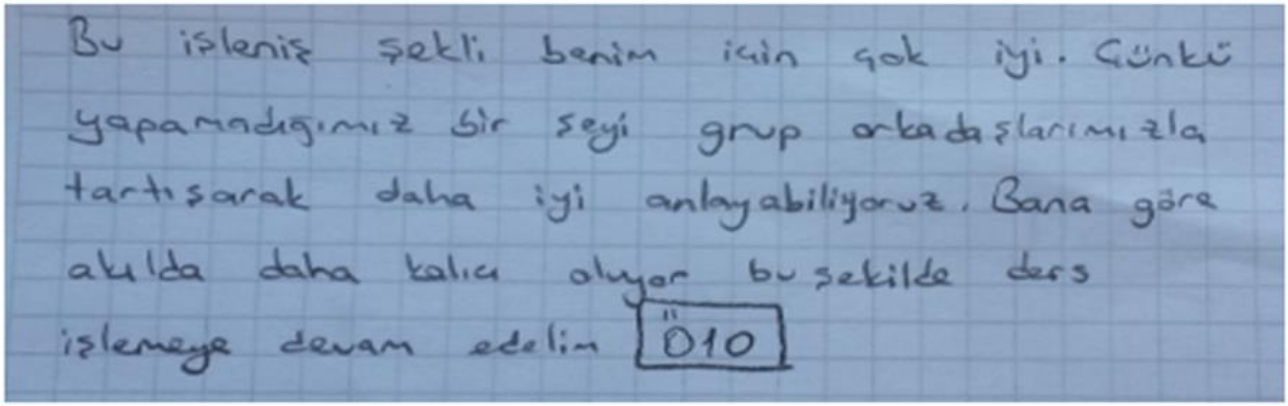
Views of S3 and S7 on Teaching of the Course with Scenarios



Views of S19 on Teaching of the Course with Scenarios



Positive Views of S6 and S11 on Teaching of the Course with Scenarios



Positive Views of S10 on Teaching of the Course with Scenarios