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|Research Article / Araştırma Makalesi|

The Effect of Algebra Teaching Supported by Thinking Class Materials on Problem Posing Attitudes of Secondary School Students[1]

Düşünen Sınıf Materyalleri İle Desteklenmiş Cebir Öğretiminin Ortaokul Öğrencilerinin Problem Kurmaya Yönelik Tutumlarına Etkisi

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Keywords

1.Materials for Thinking Classroom

2. Algebra Teaching

3. Attitudes to Problem Posing

Anahtar Kelimeler

1.Düşünen Sınıf Materyalleri

2.Cebir Öğretimi

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Abstract

Purpose: This study aims to examine the effect of algebra teaching supported by thinking classroom materials on middle school students' problem-posing attitudes.

Design/Methodology/Approach: The quasi-experimental method with a pretest-posttest control group was used in the study. The study participants, which was carried out for seven weeks in the first semester of the 2021-2022 academic year, consisted of 60 seventh-grade students attending a public middle school in the Pendik district of Istanbul. The Mathematical Problem Posing Attitude Scale (MPPAS) developed by Katrancı and Şengül (2019) to determine secondary school students' attitudes towards posing mathematical problems was used as a data collection tool in data collection in the research.

Findings: The MPPTS posttest scores applied to the experimental and control group students after the instruction showed a significant difference in favor of the experimental group. The positive effect of algebra teaching supported by thinking classroom materials applied to the experimental group on the problem-posing attitudes of secondary school students was observed.

Highlights: No study has been found that measures students' attitudes towards problem-posing in algebra teaching supported by thinking classroom materials. Considering that students' problem-posing attitudes are important, this study is thought to contribute to the literature.

Öz

Çalışmanın amacı: Bu çalışmanın amacı düşünen sınıf materyalleriyle desteklenmiş cebir öğretiminin ortaokul öğrencilerinin problem kurma tutumlarına etkisini incelemektir.

Materyal ve Yöntem: Çalışmada ön test- son test kontrol gruplu yarı deneysel yöntem kullanılmıştır. 2021-2022 eğitim öğretim yılının birinci döneminde yedi hafta boyunca gerçekleştirilen çalışmanın katılımcıları İstanbul ili Pendik ilçesinde bir devlet ortaokuluna devam eden 60 ortaokul yedinci sınıf öğrencisiden oluşturmaktadır. Araştırmada verilerin toplanmasında veri toplama aracı olarak Katrancı ve Şengül (2019)'ün ortaokul öğrencilerinin matematik problemi oluşturmaya yönelik tutumlarını tespit etmek için geliştirdiği Matematik Problemi Oluşturma Tutum Ölçeği (MPOTÖ) kullanılmıştır

Bulgular: Yapılan öğretimin ardından deney ve kontrol grubu öğrencilerine uygulanan MPOTÖ son test puanlarının deney grubu lehine anlamlı farklılaştığı sonucuna ulaşılmıştır. Deney grubuna uygulanan düşünen sınıf materyalleri desteklenmiş cebir öğretiminin ortaokul öğrencilerinin problem kurma tutumları üzerine olumlu etkisinin gözlemlendiği sonucu ortaya çıkmıştır.

Önemli Vurgular: Düşünen sınıf materyalleri ile desteklenmiş cebir öğretiminde öğrencilerin problem kurmaya yönelik tutumlarını ölçen çalışma çalışmaya rastlanmamıştır. Öğrencilerin problem kurma tutumlarının önemli olduğu düşünüldüğünde bu çalışmanın alan yazına katkı sağlayacağı düşünülmektedir.

[1] This study is part of the first author's master's thesis.

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INTRODUCTION

Problem-posing is an essential competency in the mathematics curriculum, distinct yet equally important as problem-solving. A review of the literature reveals that this mathematical activity has been defined in various ways by researchers, including terms such as "problem designing" or "problem-posing" (Cankoy & Darbaz, 2010; Kılıç, 2011; Ünveren-Bilgiç & Çaylan, 2018; Katrancı & Şengül, 2019). In the Middle School Mathematics Curriculum (2018), problem posing is a skill intended to be realized after the problem-solving steps (p. 27). The most common definition of problem-posing skill was made by Silver (1994) as creating new problems based on an existing mathematical situation or posing a new problem in the problem-solving process.

Problem posing is a potent mathematical activity that can integrate mathematical knowledge with existing knowledge (Kılıç, 2017). It includes many cognitive competencies such as problem posing, solving daily life problems and mathematical situations by formulating, choosing appropriate approaches to a mathematical situation, and learning by associating different mathematical subjects (Abu-Elwan, 1999). Problem posing, expressed as a mathematical competence and used as an assessment tool that reveals students' knowledge, is also an approach that reveals the practical and important aspects of students' mathematical thinking or their learning in which they are not competent. While giving mathematical information to the learners in a mathematics course, a general framework is tried to be followed. At the same time, it aims to develop the mathematical thoughts of the learners by using different approaches (Alkan & Bukova Güzel, 2005).

The studies on problem posing in the literature show that there are different problem-posing frameworks (English, 1997; Brown & Walter, 1993; Christou et al., 2005; Stoyanova & Ellerton, 1996; Stoyanova, 2003; Kılıç, 2013). Christou et al. (2005) examined problem-posing situations with cognitive processes and divided them into four categories.

● Editing quantitative information: Students are asked to pose a problem using any given picture, story, or information without limitations.

● Selecting quantitative information: The student is expected to pose a problem based on a given answer.

● Comprehending quantitative information: Students are asked to pose problems using mathematical operations or algebraic expressions.

● Translating quantitative information: The student is given tables, diagrams, or graphs and asked to create appropriate problems.

Stoyanova and Ellerton (1996) analyzed problem posing in three categories. These categories were analyzed: free problem posing, semi-structured problem posing, and structured problem posing. No restrictions can be placed on creating free problems; students are expected to pose problems involving an actual situation (Stoyanova, 2003; Kılıç, 2013). Appropriately, for this situation, an example could be given where you pose a complex math problem whose general instruction is appropriate for a real-life situation. In semi-structured problem posing, students are asked to pose a problem based on an existing situation using algebraic expressions, a figure, or a picture of a particular operation path or result (Stoyanova, 2003). Flexibility and limitations are recognized simultaneously in such activities (Kılıç, 2013). The activity "Construct a problem that can be solved by the operation $(42+18) \div 6 = 10$" can be an example of semi-structured problem posing. Structured problem-posing situations are characterized as new scenarios when a well-defined problem or situation is provided. Rephrasing a problem based on its solution and presenting it in various information formats are typical examples of this concept (Stoyanova, 2003).

Kılıç (2013) studied the problem-posing strategies of pre-service teachers. She determined that they can emerge as original strategies or common problem-posing strategies and classified them based on the problem-posing situations of Stoyanova and Ellerton (1996) and the problem-posing model of Christou et al. (2005).

The results of studies on problem posing indicate that one of the primary difficulties students face when dealing with algebraic expressions is their incomplete understanding of algebraic concepts. Research has shown that issues related to learning algebra, including misconceptions and challenges in solving and creating problems, persist (Şimşek & Soylu, 2018; Yağız, 2019; Türkmen, 2019). One of the most important reasons for these problems may be that algebra is an abstract concept not concretized enough to be adapted to daily life situations. It is seen that some mistakes made in algebra teaching cause students to have difficulties in making sense of algebraic concepts. Problem-posing is used to overcome these difficulties and analyze the difficulties students encounter while making sense of algebraic concepts (Cañadas, Molina, & del Río, 2018). It is thought that the attitude towards problem posing will determine the factors that influence success in mathematics, and developing a positive attitude will turn the students into good problem solvers. Solving and posing mathematical problems and raising students with positive mathematical attitudes are among the issues the national education system and teachers should work on by giving importance to (Katrancı & Şengül, 2019). When the literature is examined, it is seen that many studies include different methods in the field of equality and equation sub-learning of the algebra learning field (Özbey & Koparan, 2020; Karakaş, 2019; Aygün, 2019; Türkmen,2019; Arabacı,2016; Akarsu,2013; Takir, 2011; Palabıyık, 2010; Öner, 2009) but it has been reached that teaching activities based on direct thinking classroom materials for teaching algebra have not been developed, and students' problem posing performance and especially problem posing attitudes have not been examined with these activities. It is seen that these studies aim to embody the abstract structure of algebra. Not using appropriate methods and techniques in algebra teaching makes it difficult for learners to make sense of algebra concepts. It causes learning by rote by making the concepts contain algebra rules. This situation prevents students from thinking algebraically and negatively affects their ability to solve and construct verbal algebraic problems. These disruptions in the learning process cause students to develop negative thoughts about problem-posing and negatively affect their problem-posing attitudes. It is stated that secondary school students' problem-posing success is positively related to their attitudes towards mathematical problem-posing at a low level (Katrancı, 2022).

It is seen that most students have negative attitudes towards mathematics, which is perceived as an entirely abstract field by students. It can be said that students who can solve a problem they encounter in real life when they encounter the same problem in the name of mathematics course, they become afraid and withdrawn and exhibit negative attitudes (Özgen, Aydın, Dinç, Şeker, & Alkan, 2019). Bonotto (2013) states that if students are given the task of problem-solving and problem-posing related to the subjects they are interested in in the classroom environment, students' problem-solving and posing skills will develop positively. For this reason, it is thought that by using problem-posing activities involving daily life situations in the learning environment in the study, students will concretize algebraic concepts containing abstract expressions to ensure permanent learning and prevent misconceptions in teaching algebraic expressions. Enriching learning environments and designing them to encourage learners to consider abstract concepts are crucial in teaching algebra. In this context, the use of effective class materials will enhance the teaching of algebra. Additionally, during problem-posing activities, it is important to acknowledge that, along with cognitive factors, affective factors such as attitudes also play a significant role.

The researchers presented various suggestions for an ideal classroom environment that supports thinking, and appropriate methods were created. These methods are divided into the ideal learning environment and the classroom environment that supports thinking (Doğanay & Sarı, 2012). Reflective classrooms aim to create willing and engaged students who think about any task rather than finding interesting tasks for students to think about (Lilhedajl, 2022).

Lilhedajl (2022) created a thinking classroom framework to make students think and increase the thinking process's permanence. This framework, which includes a sequential order, has been called the thinking classes' generation framework. This framework, created by Lilhedajl (2022), is structured sequentially. According to the stages of the framework for creating thinking classes:

In the first stage, all three applications should be applied simultaneously, not sequentially. Randomly dividing the students into groups increases their interest and excitement about the lessons and positively affects their attendance. In discussion groups, there is a flow of information between students, and students can easily express their thoughts.

The second stage includes teaching practices, which is very important for laying the foundations for the third stage. At this stage, students are involved in the course flow and can practice what they have learned by performing their learning.

In the third stage, students are ready and willing to think about everything, including the teaching content, during the course flow. At this stage, a culture of thinking begins in the classroom. Through hints, students are provided to think, and information is conveyed, and they are reinforced. Note-taking for individualizing and concretizing the information learned in student groups also occurs at this stage.

The fourth stage is the final stage, during which all evaluations occur. All reflective classroom practices end at the fourth stage because teaching practices have been in flux up to this point, and assessment reflects teacher practice.

Since learners are actively involved in their learning processes by posing problems, teachers must design appropriate in-class learning-teaching processes in order to gain problem-posing ability (Aydoğdu-İskenderoğlu & Güneş, 2016; Hartmann, Krawitz & Schukajlow, 2021). In this context, when the studies conducted with students in the literature are examined within the framework of problem-posing in the field of algebra (Dinç, 2018; Dur, 2020; Kaya, 2020), it is seen that studies that support problem-posing by embodying algebra teaching by concretizing it with daily life have positive contributions to algebra teaching and problem posing. This research aims to create a thinking-friendly classroom environment, provide permanent learning, and help problem posing by concretizing the concepts of 7th-grade algebra teaching with thinking class materials. For this reason, it is essential to design and create learning environments in which various teaching methods and techniques are used for different sensory organs, and learners take an active role in the center to realize permanent learning.

It is predicted that mathematics will be learned more effectively with the problem-solving and creation environment created by constructing the teaching environment supported by thinking classroom materials with concrete materials containing visual elements and activities, using constructive discussions with collaborative heterogeneous groups that enable students to understand their environment and associate it with real life by mathematizing it. In addition, open-ended problems aimed at advanced thinking will significantly impact mathematical reasoning and thinking power, and learners' attitudes towards posing mathematical problems will also be positively affected by the fun and different methods used. In this sense, the study will contribute to the problem posed by the literature.

The research aimed to answer the following questions:

1. Is there a significant difference in the attitudes towards posing mathematical problems between students in the experimental group, who participated in algebra teaching supported by thinking classroom materials, and those in the control group?

2. Is there a significant difference in the scores of the experimental group students on the math problem-posing attitude scale between the pre-test and post-test?

3. Is there a significant difference in the scores of the control group students on the math problem-posing attitude scale between the pre-test and post-test?

METHODS

In the study, a quasi-experimental design with a pretest-posttest control group was used since it was desired to investigate the effect of algebra teaching supported by thinking class materials on the problem-posing attitudes of middle school seventh-grade students. Quasi-experimental designs are defined as a preferred design in research situations where random sampling cannot be done while adhering to fundamental experimental design principles, which is carried out to determine cause-effect relationships (Büyüköztürk, Kılıç-Çakmak, Akgün, Karadeniz, & Demirel, 2018; Creswell, 2007). Since the research examines the effect of two different methods on problem-solving attitudes in teaching algebra, the aim is to evaluate the new method according to the current method (Gliner, Morgan, & Harmon, 2003). The classroom environment is created using classroom materials that consider the independent variables of the research and in-class activities carried out with the traditional method. The dependent variables of the research are the attitude towards problem posing in the field of learning algebra.

Research Group

The research study group includes seventh-grade students attending a public school in the Pendik district of Istanbul during the first semester of the 2021-2022 academic year. Since it is the institution where the researcher works, the convenient sampling method was preferred among the non-random sampling methods while determining this school. In this method, compliance with the purpose of the researcher is observed (Büyüköztürk et al., 2018). The student groups in the study were formed randomly. Data were collected from 30 students in the experimental group and 30 students in the control group. The research involved 60 seventh-grade students, consisting of 36 girls and 24 boys, aged between 11 and 13 years. Considering the number of students is equal, one class experimental group was determined as one class control group. Students in B (experimental group) and A (control group) branches participated in the study. Before the experiment, both groups were pre-tested, and the results were compared. The results were equal.

Data collection tools

The study used the mathematical problem-posing attitude scale (MPPAS) prepared by Katrancı and Şengül (2019) to examine students' attitudes toward problem-posing. This study used the Mathematics Problem Posing Attitude Scale (MPPAS), developed by Katrancı and Şengül (2019), to determine middle school students' attitudes toward posing mathematical problems. While creating the scale questions, attention was paid to the relationship between cognitive, affective, and behavioral characteristics and attitude. The scale, which consisted of 68 items at the beginning of the study, was reduced to 37 items due to the factor analysis. There are 13 positive and 24 negative items on the scale. Positive items 1, 5, 10, 14, 18, 21, 24, 27, 29, 31, 32, 34 and 37 of the scale items; 2, 3, 4, 6, 7, 8, 9, 11, 12, 13, 15, 16, 17, 19,20, 22, 23, 25, 26, 28, 30, 33, 35 and 36 have negative items. Forms. The scale was prepared in a 5-point Likert type as "I strongly disagree (1), I do not agree (2), I neither agree nor disagree (3), I agree (4), and I completely agree (5)".

MPPAS consists of three dimensions: "Dislike," "Self-confidence" and "Self-confidence". 2, 4, 11, 12, 13, 15, 16, 17, 19, 20, 22, 23, 25 and 26 on the scale; items containing the dislike factor; Items including 3, 6, 7, 8, 9, 28, 30, 33, 35 and 36 insignificance factors; 1, 5, 10, 14, 18, 21, 24, 27, 29, 31, 32, 34 and 37 were determined as items containing self-confidence factor. Cronbach Alpha value for each sub-dimension of the scale, respectively. 90, .85, .81; for the whole scale. It was measured as 91. In the factor analysis for 37 items of the scale, It was found that the first factor contributed to the common variance of 16.809%, the second factor 12.403%, and the third factor around 11.190%. The total contribution of the three factors of the scale was determined as 40,402%. As a result of the confirmatory factor analysis performed in the final version of MPPAS, the ratio of $XX2/ssss$ was found to be 2.71 on the scale.

Data collection procedure

The study was designed to last four weeks, encompassing twenty course hours focused on the algebra curriculum for 7th grade. Its aim was to assess the impact of algebra instruction supported by thinking class materials on students' attitudes towards problem posing. To facilitate this, a learning environment and materials were specifically prepared for the experimental group. In contrast, the control group was provided with a learning environment that utilized worksheets.

In the research, teaching the equality and equation gains of the 7th-grade algebra subject in the experimental group was carried out with activities prepared according to thinking classroom material (TCM). These activities were created by examining the achievement tests, skill-based questions, and PISA questions published by the Ministry of National Education.

The prepared lesson plans were examined by two different mathematics teachers and an academician who is an expert in mathematics education and arranged for use in the study. Expert opinion was sought for the six worksheets prepared for use in the experimental group. Necessary arrangements were made to ensure the linguistic compatibility of the activities. In addition, within the framework of the opinion received from the experts that the problems appropriate for real-life situations given in the activities should appeal to every student, the problems were revised, and the activity papers were ready for application.

In the control group, lesson activities were prepared using middle school mathematics textbooks (MEB, 2020) prepared by the Ministry of Education within the framework of the mathematics curriculum. The expert opinion made necessary corrections. The linguistic compatibility of the activities prepared for the control group was checked, and necessary arrangements were made.

In order to determine whether there is a statistically significant difference between the experimental and control groups in terms of their attitudes towards problem posing, the mathematics problem posing attitude scale (MPPAS) was applied to the students in both groups as a pre-test before the application was made. After the pre-test applications were carried out for both groups and the equivalence between the groups was achieved, the 4-week period of the experiment began. During 20 lesson hours, teaching the equality and equation sub-learning domain achievements was carried out in the classroom environment supported by the researcher's thinking class materials to the experimental group and by applying activity papers containing the traditional teaching method to the control group.

Learning environments were organized by considering the stages of creating a thinking class in the environment created while the lesson was being taught with the thinking class materials. After all the students answered the activity papers from the beginning of the lesson, the researcher asked randomly selected student groups to read the answers given by the students to the questions in the activity and to solve these questions on the board. In response to the answers given by the students, the researcher provided feedback and corrections where necessary. At the end of the study, the researcher resolved the answers to the other exercises in the activity sheets and the solutions to the problems, and the lessons ended.

Table 1. Study Schedule for Experimental and Control Groups

1. Week (1 lesson + 1 lesson hour)	“PPT” and “MPPAS” were applied to two groups as a pretest.
2. Week (5 lesson hours)	Teaching was carried out to understand the principle of preservation of equality and in-class activities were carried out.
3. Week (5 lesson hours)	The concept of a first-order equation with one unknown and activities aimed at establishing a first-order equation with an unknown in accordance with given real-life situations were taught.
4. Week (5 lesson hours)	Practice exercises were conducted to solve first-order equations with one unknown.
5. Week (5 lesson hours)	In-class exercises and activities were carried out to solve problems that required establishing a first-order equation with one unknown.
6. Week (5 lesson hours)	In-class and activities were carried out to pose problems that required establishing a first-order equation with one unknown.
7. Week (1 lesson hour + 5 lesson hours)	“PPT” and “MPPAS” were applied to two groups as a posttest.

Planning Lessons in a Thinking Classroom Environment and Activity Sheets for Algebra Teaching Supported by Thinking Classroom Materials

Learning environments have been arranged by considering the stages of creating a thinking class in the environment created while teaching with thinking classroom materials. After all, students had answered the activity sheets from the class time when the study started. The researcher randomly selected student groups to read the answers given by the students to the questions in the activity and to solve these questions on the board. In response to the students' answers, the researcher provided feedback and corrections where necessary. At the end of the study, the answers to the other exercises and the solutions to the problems in the activity sheets were solved by the researcher, and the lessons ended.

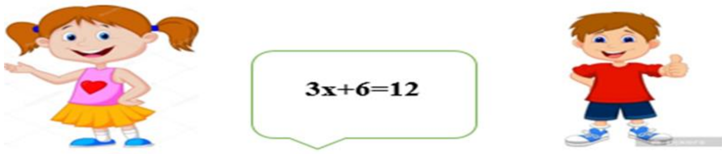
The Anticipation Phase: In this stage, students create their learning goals by becoming aware of their existing knowledge within the framework of a conversational conversation. A discussion environment is created to create and understand new information using old information. The first exercise in the activities prepared for the course represents this stage. Figure 1 below shows a section from the activity sheet used in the course. The dialogue in the activity was read and discussed with the students, and the lesson continued.

ETKINLIK-3

DENKLEM MI, KURALIM BAKALIM?

KAZANIM: Birinci dereceden bir bilinmeyenli denklemi tanır ve verilen gerçek hayat durumlarına uygun birinci dereceden bir bilinmeyenli denklem kurar.

Süre: 5 ders saat



Iki iyi arkadaş olan Ayça ve Kerem "3x+6=12" hakkında konuşurlar.

Ayça: 3x+6 cebirsel bir ifadedir. Içinde bilinmeyen ve bir de toplama işlemi var.

Kerem: "=" sembolü de var. Hatta =12. Aklıma terazi örneği geldi Ayça.

Ayça: Evet terazinin bir kefesi 3x+6, diğer kefesi de 12.

Kerem: Bu ifadenin bir adı vardı neydi?

Ayça: Neydi hadi hatırla bakalım. Içinde bilinmeyen bulunan ve bilinmeyenin bazı değerleri için doğru olan ifadelere ne denildiğini öğrenmiştik?

Kerem: Buldum. Denklem olarak öğrenmiştik.

Figure 1. Experimental Group work Sheet Sample

The Building Knowledge phase: This is the stage where students actively discuss, ask questions, try to make sense of the material, share their thoughts, and make inferences during the learning process. The second and third exercises in the prepared lesson plans include this stage. Figure 2 below shows a section from the activity sheet used in the course. The dialogue in the activity was read and discussed with the students, and the lesson continue

ALIŞTIRMA 2:

Can ile Han'ın yaşları toplamı 50 dir. 5 yıl sonra Han'ın yaşı Can'ın yaşının iki katı olacağına göre Han'ın şimdiki yaşını bulmamızı sağlayan denklemi yazınız.

ÇÖZÜM:

Figure 2. Experimental Group Work Sheet Sample

The Consolidation Phase: This phase is included in the activities at the end of the lesson. As a guide, the teacher completes the lesson by asking students to think about what they have learned, make sense of the information, and establish the relationship between their old learning and new learning. Figure 3 below shows a section from the activity sheet used in the course. The dialogue in the activity was read and discussed with the students, and the lesson continued.

DOĞA PARKI

Bir doğa parkında geyikler ve kurtlar koruma altına alınmak isteniyor. Bu parkta insanların kurt ve geyik avlamasının yasak olduğu biliniyor. Bir grup 7. sınıf öğrencisi, av yasağını destekleyici bir çalışma yapıyorlar. Çalışmaya başlamadan önce bu hayvanlara nelerin zarar verdiğini araştırıyorlar.

Öğrendikleri bilgiler şu şekildedir:

- 2 geyik derisinden 1 ceket
- 1 geyik derisinden 2 ayakkabı
- 3 kurt postundan 1 kaban
- 1 kurt postundan 3 şapka yapılır.

Öğrenciler yaptıkları çalışmayı park müdürüne teslim ediyorlar. Park müdürü çalışma başarılı olursa bu öğrencilere etkinlik düzenleyeceğini söylüyor.

Öğrencilerin Yaptığı Çalışma

Hayvanlar	Bir av için ceza	Birden fazla av için ceza
Kurt	4000 TL	Avlanan hayvan başına 5000 TL
Geyik	3000 TL	Avlanan hayvan başına 4500 TL

(Avda kullanılan araç-gereçler zarar verici ise ellerinden alınmaktadır, değilse bedeli ödenmek şartıyla geri verilmektedir.)

Bir grup avcı 4 ceket, 3 kaban, 16 ayakkabı ve 24 şapka yapabilecek şekilde, hayvanları canlı bir şekilde avlayıp tanesi 5 geyik veya 6 kurt alan, kapalı kasa kamyonetlerin içine koyuyorlar. Ancak farklı hayvanları aynı kamyonete yüklemiyorlar. Bu avcılar gidecekleri yere varamadan doğa parkı bekçileri tarafından yakalanıyorlar.

Verilen bilgileri kullanarak 3 tane problem oluşturunuz.

Figure 3. Experimental Group Work Sheet Sample

Data analysis

In order to analyze the data for the attitude scale of posing a mathematical problem, the total scores of the experimental group and control group were calculated and their normal distribution was examined. When the descriptive statistics were examined for the control of normality, it was seen that the kurtosis and skewness coefficients were between -1 and +1. The fact that these values are between -1 and +1 supports the normal distribution of the data (Büyüköztürk, 2019). It was observed that the MPPAS pretest-posttest scores of the experimental group and the control group showed a normal distribution (p>0.05). Therefore, it was deemed necessary to use samples t-test independent of parametric tests for the experimental group and control group in the analyzes for MPPAS. “Eta Square Effect Size” values were calculated and presented in the findings in order to determine the activity level of the groups with different independent samples t-test values. Independent samples t test Eta Square Value (η2)

$$\eta^2 = \frac{t^2}{t^2 + (N_1 + N_2 - 2)}$$

calculation formula; (Büyüköztürk, 2019).

In addition, the dependent samples t-test, one of the parametric tests, was used in the in-group analysis of the MPPAS pretest-posttest scores of the experimental group and the MPPAS pretest-posttest scores of the control group.

FINDINGS

In this segment of the research, we investigated the impact of problem-posing activities in algebra instruction, supported by thinking class materials, on the problem-posing attitudes of 7th-grade students. We assessed whether there was a statistically significant difference in the total scores from the Mathematical Problem-Posing Attitude Scale (MPPAS) before and after the intervention for both the experimental and control groups. We utilized a dependent samples t-test to analyze the scores within the experimental group and a separate independent samples t-test to compare the experimental and control groups. The results of these tests are provided in Table 2.

Table 2. Experimental and Control Groups MPPAS Pre-Test Scores t-Test Results

GROUP	N	X̄	S	t	sd	P
Control group	30	132,761	19,391	0,992	58	0,325
Experimental group	30	133,000	21,472			

When Table 2 was examined, it was concluded that there was no significant difference between the control group and the experimental group in the pre-test MPPAS scores before the application [t(58) = 0.992; p> 0.05]. Before the application, it was concluded that the scores of the control and experimental groups' attitudes toward posing a mathematical problem were equal.

Table 3. t-Test Results of the Experimental Group MPPAS Pre-Test Post-Test Scores

Group	X̄	N	S	sd	t	p
Ötop	138,000	30	21,472	29	3,093	0,013
Stop	118,200	30	22,561			

When Table 3 is examined, it is concluded that there is a significant increase between the mean scores of the students in the experimental group in the MPPAS pre-test (Eutop) and post-test (Stop) [t(29)=3,093; p<0.05). It has been concluded that "algebra teaching supported by thinking classroom materials" carried out with the students in the experimental group is an effective method in increasing students' attitudes towards posing mathematical problems.

Table 4. t-Test Results of the Control Group MPPAS Pre-Test Post-Test Scores

GROUP	X̄	N	S	sd	t	p
Ötop	132,7667	30	19,391	29	4,613	0,091
Stop	111,7667	30	16,093			

When Table 4 was examined, it was concluded that there was no significant increase in the mean scores of the students participating in the control group in the MPPAÖ pre-test (Ötop) and post-test (Stop) [t(29)= 4.613; p>0.05]. By comparing the students' pre-research and post-research achievement scores, it was examined whether there was a change in the students' attitudes toward posing a mathematical problem. The algebra teaching studies conducted with the students in the control group found that it did not affect their attitudes toward posing a mathematical problem.

At the end of the application, the scores of the two groups from the MPPAÖ posttest were examined to determine whether there was a significant difference between the attitude scores of the control group and the experimental group students towards posing a mathematical problem. The obtained data were analyzed using the independent groups t-test, and the findings are given in Table 5.

Table 5. Experimental and Control Groups MPPAS Post-Test Evaluation Results

GROUP	N	X̄	S	t	sd	P
Control group	30	133,761	16,093	1,274	58	0,021
Experimental group	30	138,202	22,561			

DISCUSSION

When the literature is examined, it is seen that problem-posing activities positively affect students' beliefs, attitudes, skills, and self-efficacy toward mathematics (Özgen & Bayram, 2020; Katrancı &Şengül, 2019; Adal &Yavuz, 2017; Silver, 1994). Since learners are actively involved in their learning processes by posing problems, teachers need to design appropriate in-class learning-teaching processes to gain problem-posing ability (Aydoğdu İskenderoğlu & Güneş, 2016; Hartmann, Krawitz, & Schukajlow, 2021). In this context, when the studies conducted with students in the field of algebra are examined within the framework of problem posing in the field (Dinç, 2018; Dur, 2020; Kaya, 2020), it is seen that studies that support problem-posing by concretizing algebra teaching and associating it with daily life have positive contributions to algebra teaching and problem posing.

This study aimed to create a thinking-friendly classroom environment and provide permanent learning by concretizing the concepts of 7th-grade algebra teaching with thinking classroom materials and to help with problem posing. For this reason, it is essential to design and create learning environments where various teaching methods and techniques for different sense organs are used, and learners actively take a role in the center for permanent learning. It is predicted that mathematics will be learned more effectively with the problem-solving and creation environment formed by structuring the teaching environment supported by thinking classroom materials with concrete materials containing visual elements and activities, enabling students to understand their environment and associate it with real life by mathematicizing it, and constructive discussions with collaborative heterogeneous groups that enable peer learning. In addition, open-ended problems that aim to develop advanced thinking will significantly affect mathematical reasoning and thinking power. The fun and different methods will positively affect learners' attitudes towards posing mathematical problems. In this sense, the study will contribute to the literature on problem posing.

In order to examine the effect of algebra teaching supported by thinking class materials on middle school students' attitudes towards problem posing in the study, MPPAS was applied to the experimental and control group students as a pre-test and post-test. Before the application, it was observed that the attitude scores of the experimental and control groups toward posing a mathematical problem were equal. The problem is that the attitudes of both groups are at the same level. After the teaching, it was concluded that the MPPAS post-test scores applied to the experimental and control group students differed significantly in favor of the experimental group. It was concluded that the positive effect of algebra teaching, supported by the thinking class materials applied to the experimental group, on secondary school students' attitudes towards problem posing was observed. In her study with secondary school students, Katrancı (2022) showed that students' attitudes towards problem posing were effective in their success in problem posing.

Although there is no study examining the effect of algebra teaching supported by thinking classroom materials on the problem-posing attitudes of secondary school students, it is seen that there are studies (Katrancı & Şengül, 2019) examining the relationship between students' problem-posing attitudes, their problem posing performance, and their attitudes towards problem-solving and mathematics. Katrancı and Şengül (2019), in their study aiming to examine the relationships between middle school students' attitudes towards posing mathematical problems, their attitudes towards solving mathematical problems, and their attitudes towards mathematics, determined that the attitudes of middle school students towards posing, solving and solving mathematical problems and mathematics are in a positive sense and at a high level. When these results are examined, it is seen that there is a high level of relationship between students' attitudes towards creating and solving mathematical problems and mathematics.

In the studies, it is seen that the attitude toward problem posing is important in the self-efficacy perceptions of the students (Görgün, 2020) and the attitude towards mathematics (Ada, Demir & Öztürk, 2020). Görgün (2020) concluded that the problem-posing attitudes of the students are at a moderate level. In his study, he examined the perceptions of mathematics self-efficacy of secondary school students and their attitudes toward posing mathematical problems. Ada, Demir, and Öztürk (2020) concluded that sixth-grade students developed a positive attitude by breaking the prejudice they formed against mathematics while posing problems.

CONCLUSION AND RECOMMENDATIONS

Problem-posing performance and problem-posing attitude are related concepts in mathematics teaching. It was found that the problem-posing attitudes of students with high problem-posing performance were positively affected. Students who can pose problems develop self-confidence towards mathematics, and their anxiety during the learning process of mathematics is reflected in their attitudes toward the lesson. Thus, the problem-posing attitudes of the students who are more interested in the mathematics lesson are also positively affected. The process of forming an attitude through experiences can be included in the teaching activities in which the changes are observed by observing the learners in their learning environments. It is thought that the attitudes towards mathematics and posing mathematical problems can be changed positively with learning and teaching environments that support students' thinking, course contents that enable students' cognitive and affective processes to be effective, and course contents that offer the chance to learn by doing and experiencing.

Suggestions

● This research was designed and implemented at the seventh-grade level. A similar study can be conducted with students at various grade levels.

● The effect of algebra teaching supported by thinking classroom materials on students' affective skills, such as problem-solving and constructing self-efficacy, can be examined.

● The learning environment and activities can be prepared with reflective classroom materials to demonstrate problem-posing performance for different mathematics subjects.

● The effect of algebra teaching supported by thinking class materials using different problem-posing approaches on middle school students' problem-posing attitudes can be investigated.

● It may be suggested to investigate the effect of similar teaching materials to be prepared according to thinking class materials on larger sample groups or at different grade levels.

Declaration of Conflicting Interests

The author(s) declare that there are no potential conflicts of interest related to the research, authorship, or publication of this article.

Statements of publication ethics

We affirm that this study adheres to ethical standards and that all research and publication ethics have been meticulously followed.

Examples of author contribution statements

E.K. and Ç.K conceived of the presented idea. E.K. developed the theory and performed the computations. E.K. and Ç.K. verified the analytical methods. Ç.K. encouraged E.K. to investigate problem posing and supervised the findings of this work. All authors discussed the results and contributed to the final manuscript.

Researchers' contribution rate

The study was conducted and reported through equal collaboration among the researchers.

Ethics Committee Approval Information

This research was carried out with the approval of the Istanbul Medeniyet University Educational Sciences Ethics Committee. The approval decision was issued on December 7, 2020, with the reference number 2020/04-10.

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