INVESTIGATION OF THE CHANGE IN SIXTH GRADE STUDENTS' PROBLEM SOLVING ABILITIES, ATTITUDE TOWARDS PROBLEM SOLVING AND ATTITUDE TOWARD MATHEMATICS AFTER MATHEMATICS INSTRUCTION BASED ON POLYA'S PROBLEM SOLVING STEPS

A THESIS SUBMITTED TO
GRADUATE SCHOOL OF SOCIAL SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

VEYSEL YILDIZ

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
THE DEPARTMENT OF
ELEMENTARY SCIENCE AND MATHEMATICS EDUCATION

DECEMBER 2008

Approval of the Graduate School of Social Sciences

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ABSTRACT

INVESTIGATION OF THE CHANGE IN SIXTH GRADE STUDENTS' PROBLEM SOLVING ABILITIES, ATTITUDE TOWARDS PROBLEM SOLVING AND ATTITUDE TOWARD MATHEMATICS AFTER MATHEMATICS INSTRUCTION BASED ON POLYA'S PROBLEM SOLVING STEPS

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December 2008, 98 pages

Teaching mathematics is now gaining more importance, as the new elementary mathematics school curriculum has been adapted to Turkish Educational System. One of the main goals of the curriculum reform is to increase elementary school students' problem solving abilities in mathematics (Koç, Işıksal & Bulut; 2007). In this study, the aim is to investigate the change in sixth grade students' problem solving abilities, attitude towards problem solving and attitude toward mathematics after mathematics instruction based on Polya's problem solving steps. The sample of this study consisted of 53 sixth grade students from an elementary school in Istanbul. The participants consist of a class selected conveniently among all the sixth grade classes in the school. In these selected classes, mathematical problems are solved according to the Polya's problem solving steps by following different problem solution techniques during the semester.

At the end of this study, the three main results were found: 1) Instruction based on Polya's step has significantly affected students' problem solving abilities in a positive way, 2) students' attitudes towards problem solving has changed in a positive way, 3) students' attitudes towards mathematics is enhanced by the instruction based on Polya's problem solving steps.

Keywords: Problem Solving Ability, Attitude Towards Problem Solving, Attitude Towards Mathematics.

ÖZ

POLYA'NIN PROBLEM ÇÖZME ADIMLARINA DAYALI MATEMATİK ÖĞRETİMİNDEN SONRA ALTINCI SINIF ÖĞRENCİLERİNİN PROBLEM ÇÖZME BECERİLERİ, PROBLEM ÇÖZMEYE KARŞI TUTUMLARI VE MATEMATİĞE KARŞI TUTUMLARINDAKİ DEĞİŞİMİN İNCELENMESİ

Yıldız, Veysel

Yüksek Lisans, İlköğretim Fen ve Matematik Alanları Eğitimi

Tez Yöneticisi: Dr. Mine IŞIKSAL

Aralık 2008, 98 sayfa

Matematik öğretimi yeni ilköğretim matematik dersi programının tasarlanıp uygulanmaya başlanması ile daha bir önem kazanmıştır. Programdaki değişimin önemli hedeflerinden birisi de; öğrencilerin matematiksel problem çözme ve problem oluşturabilme yeteneklerini arttırmaktır (Koç, Işıksal, & Bulut; 2007). Bu çalışmanın amacı Polya'nın matematik adımlarına dayalı matematik öğretiminin 6. sınıf öğrencilerinin problem çözme yeteneklerindeki, problem çözmeye yönelik tutumlarındaki ve matematiğe yönelik tutumlarındaki değişimi incelemektir. Bu çalışmanın örneklemini İstanbul'daki bir ilköğretim okulunun6. sınıflarından seçilen 53 öğrenci oluşturmuştur. Bu sınıfta çalışmanın sürdürüldüğü 17 hafta boyunca problem çözümünde Polya'nın metodu kullanılmıştır.

Bu çalışmanın sonunda 1) Öğrencilerin matematik problemlerini çözme becerilerinde önemli bir artış olduğu, 2) Polya'nın adımlarına dayalı matematik öğretiminin öğrencilerin problem çözmeye yönelik tutumlarını arttırdığı, ve 3)

matematiğe karşı olumlu tutum geliştirmelerinde olumlu rol oynadığı bulunmuştur.

Anahtar Kelimeler: Problem Çözme Becerisi, Problem Çözmeye Karşı Tutum, Matematiğe Karşı Tutum.

ACKNOWLEDGEMENTS

I would like to thank firstly my previous advisor Dr. Yusuf KOÇ and then special thanks to Dr. Mine IŞIKSAL for her interest, especially patience and the feedbacks she tried to give until late at night.

I would like to thank my family whose love and care.

I would like to thank my unique friend Emre BAYRAK for the precious support.

I would like to thank my friend Şebnem BOYRAZ for her close interest.

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LIST OF ABBREVIATIONS

PSOT:	Problem Solving Test
PSAS:	Problem Solving Attitude Scale
MAS:	Mathematical Attitude Scale
PREPSOT:	Students' pretest scores on Problem Solving Test
POSTPSOT:	Students' posttest scores on Problem Solving Test
PREPSAS:	Students' pretest scores on Problem Solving Attitude Test
POSTPSAS:	Students' posttest scores on problem Solving Attitude Test
Sig:	Significance
df:	Degree of freedom
N:	Sample size
α:	Significance level
F:	F-Statistics
St.dev:	Standard Deviation
M:	Mean
p:	Probability
Paired-sample t test:	Analysis of Variance
SPSS:	Statistical Packages for Social Science

CHAPTER I

INTRODUCTION

Mathematics is an inevitable part of individuals' daily life and consulted to use in every field of the life as well. The important thing is to enable individuals to apply mathematics in the situations that they confronted. In this aspect, teaching mathematics gains more importance to enact needed knowledge and skills to apply in daily life situation (Saleh, 1990). Application and usefulness of mathematics appear in the part of problem solving and problem construction named as simply problem posing in mathematics. Thus, problem solving is part of the adaptation in that it plays important role on solving the situation and producing cases being confronted in life. Individuals face with situations or cases that they have to solve on their own. In that aspect, problem solving and posing and its teaching are actually crucial for making it meaningful for students especially at the early stage (Karataş & Güven, 2003).

Recently, problem solving has become important and it spreads in every level at schools all over the world, so does in Turkey. In order to catch up with the latest development on teaching how to solve problem, Turkish National Educational Board has integrated new curriculum into elementary schools. There has been an educational reform in mathematics as done in science, social science, life science and Turkish language teaching to develop students in academically, socially and individually with the awareness of outside commchaptery (Koç, Işıksal & Bulut; 2007). In fact, this new curriculum is integrated into our Turkish national educational system to change traditional views of teaching mathematics in both secondary and middle school level. In this expect, new curriculum has focused on student base instruction rather than teacher directed instruction. In this program, the student is in the center of the

learning. In addition, the mathematics instruction is based on individual differences in learning and individual development by transforming their knowledge to environmental conditions (Babadoğan & Olkun, 2005).

According to National Council of Teachers of Mathematics (2000), problem solving is a part of standards and expectations for Principles and Standards for mathematics teachers among the other standards and expectations of communication, reasoning and proof, connections and representations. In addition, the problems in new implemented curriculum stress more on students' adaptation to environment where they live and interact (Bulut, 2007). They are for focusing on school mathematics that is connected with student's daily life situation or experiences (NCTM, 2000). The concept "problem" has been shaped according to the students' needs and experiences. The problems should be more relevant to social environments and issues, daily life cases and needs to be able to get attention of students (Babadoğan & Olkun, 2005).

To improve students' attitude toward mathematics is also one of the important aims of the new curricular movement. New implementation makes students active in their individual and group works. Students participate in learning with activities, materials considering motor skills, self expression, reasoning, and with thinking process (Bulut, 2007). Babadoğan and Olkun (2005) states that the emphasis in new curriculum is more on students' interest in learning of mathematical concepts and is an encouragement to have positive attitude toward mathematics covering problem solving.

It could be deduced that new curricular change has given a new perspective to mathematical problem solving as a part of teaching mathematics. The problem concept has changed from routine problems to real life problems. Babadoğan and Olkun (2005) support that in mathematical problem solving the main stress has become daily use of mathematical knowledge. At that point, problem solving has an important role on teaching mathematics for a part of curriculum development.

1.1. Purposes of the Study

In this study, the researcher has implemented the new adapted mathematics curriculum into his classroom. One of the reasons for conducting present study is to enable teachers to put light on the relation between new curriculum implementation and students' problem solving abilities. The other reason is to investigate the effect of problem solving method on students' problem solving skills in order to contribute teachers for helping develop highly structured problem solving activities in their problem solving session. This study is also conducted to provide suggestions for teachers with preparing better environment to enhance students' problem solving skills. Another reason is to see the changes of this new curriculum instruction on students' attitude towards mathematics and problem solving. Lastly, although the new curriculum which includes mathematics instruction based on Polya's problem solving steps implemented in 2004, there is limited number of studies that investigates the changes of students' problem solving skillsafter given instruction. In this study, one of problem solving methods that Polya's offered was used during implementation. The research questions are mainly trying to find how the students' problem solving abilities will be changed after mathematics instruction based on Polya's problem solving steps.

1.2. Significance of the Study

The National Council of Teachers of Mathematics (2000) states that it is important to use different materials, methods and other instructional tools through mathematical processing and learning to support positive outlook to mathematics. In addition, students' reasoning, constructing and evaluating mathematical argument is crucial in mathematics. As in NCTM (2000) standards, Turkish mathematics curriculum emphasize students' problem solving, reasoning, connecting to other fields, thinking logically, making

estimation, claiming the thoughts, and working cooperatively; basically reform aimed to make students active in learning process (Bulut, 2004). Teaching with mathematical activities, various materials and representations lies under the concepts by doing or by living to make students involve in mathematical lessons and understanding the concepts.

Before the educational reform was integrated, teaching mathematics was only kind of transforming knowledge from teacher to students with direct instruction. Problems were in the form of routine far from the real life mostly, small number of examples existed (Babadoğan & Olkun, 2005). Bulut (2007) also showed that in problem solving session by old instructional method, the students could not be part of the solution; they were assessed by exams and oral expression. The study claimed that those kinds of reasons caused the students to feel uncomfortable in problem solving and loss of self-confidence in success. If they did not reflect their problem solving skills in their exam papers, then they would get bad grades, because the assessment depended on only averages of results of these exams. In addition, in Third International Mathematics and Science Studies (TIMSS) released in 1999 among 8^{th} grade students in 38 countries, the students participated from Turkey were in 31^{st} position. Student's low scores and other results showed that the reform movement was needed to enact the ways of teaching mathematics meaningfully. Thus, this requirement has brought about the new approach to mathematics instruction. The findings mentioned above also support the idea that mathematics instruction and its important part of problem solving.

As mentioned above, problem solving is so important in the implementation of the new curriculum, however, there are few studies performed to investigate the effect of mathematics instruction on students'problem solving abilities (Koç, 1998; Akınoğlu & Tandoğan, 2006). Thus, in this study it was aimed to investigate the change of students' problem solving skills and their attitudes towards both problem solving and mathematics after instruction based on Ploya's problem solving steps.

1.3. The Research Questions and Hypotheses

1. Does mathematics instruction based on Polya's problem solving steps increase sixth grade students' problem solving abilities on numbers, geometry, measurement, and algebra units?

Q1: Is there significant mean difference among pre-test and post-test scores of sixth grade students' problem solving abilities on numbers, geometry, measurement, and algebra units after implementation of mathematics instruction based on Polya's problem solving steps?
The hypothesis related to the first main problem:

Null hypothesis 1: There is no significant mean difference among pre-test and post-test scores of sixth grade students' problem solving abilities on numbers, geometry, measurement, and algebra units after implementation of mathematics instruction based on Polya's problem solving steps?

2. Does mathematics instruction based on Polya's problem solving steps increase sixth grade students' attitudes towards problem solving on numbers, geometry, measurement, and algebra units?

Q2: Is there significant mean difference among pre-test and post-test scores of sixth grade students' attitudes towards problem solving on numbers, geometry, measurement, and algebra units after implementation of mathematics instruction based on Polya's problem solving steps?
The hypothesis related to the second main problem:

Null hypothesis 2: There is no significant mean difference among pre-test and post-test scores of sixth grade students' problem solving attitude on numbers, geometry, measurement and algebra units after implementation of mathematics instruction based on Polya's problem solving steps.

3. Does mathematics instruction based on Polya's problem solving steps increase sixth grade students' attitudes towards mathematics on numbers, geometry, measurement, and algebra units?

Q3: Is there significant mean difference among pre-test and post-test scores of sixth grade students' attitudes towards mathematics on numbers, geometry, measurement, and algebra units after implementation of mathematics instruction based on Polya's problem solving steps?
The hypothesis related to the fourth main problem:

Null hypothesis 3: There is no significant mean difference among pre-test and post-test scores of sixth grade students' attitudes towards mathematics on numbers, geometry, measuring, and algebra units after implementation of mathematics instruction based on Polya's problem solving steps?

1.4. Definitions of Important Terms

Problem Solving: Problem solving refers to the process of relating previously attained knowledge to new and unusual situations (NCTM, 2003). In addition, problem solving for students is a practical way of using mathematics in order to be aware of the daily life and makes the mathematics useful (Doorman, et al., 2007). In this study, problem solving refers to the solving mathematical problems on numbers, geometry, measurement, and algebra units according to Polya's problem solving steps.

Mathematics Instruction based on Polya's Problem Solving Steps: The mathematics instruction refers to the instruction based on Polya's problem solving steps thatare understanding the problem, creating a plan, solving the problem, checking the problem, and extension of the problem (Chamot, Dale; O'Malley; Spanos, 1992). It also includes problem solving strategies specified

in the literature part. Those strategies help to solve a problem in different ways to make it more understandable and meaningful for most of the students.

Problem Solving Ability: Problem Solving Ability refers to having the capability of solving different kinds of mathematical problems (Wilson, Fernandez & Hadaway, 1993). In this study, it refers to elementary school students' cognitive capability of using Polya's problem solving steps in mathematical problem solving.

Problem Solving Steps of Polya: Polya (1954) introduced a holistic approach to mathematical problem solving. It refers to the following steps 1) understanding the problem, 2) creating a suitable plan for solution, 3) solving the problem via a method 4) checking solution steps, and 5) extending.

1.5. Assumptions of the Study

In this study, the tests lasted two lesson hours. During the test, the participants answered the open-ended questions intentionally. In addition, the four tests were administered under the same conditions. Moreover, as the researcher was teaching, students perceived him as a mathematics teacher in the classroom. Each student was treated equally in the classroom. As to come to assessment, students' tests were evaluated without looking at their names.

1.6. Limitations of the Study

In the limitation part, the difficulties that researcher confronted while conducting the study will be stated. Firstly, the classrooms were crowded; there were 58 students in the class, so there was noise during implementation. In addition, there were not enough materials in the school; the researcher provided almost all of the materials. Even, the students were sometimes shared the given materials. Moreover, activities lasted longer than the actual time. In one hour

problem solving session, few problems were solved because of time limitation and having a crowded classroom. Since Polya's problem solving steps took some time to apply, limited numbers of problems were solved during the problem solving sessions. Another limitation was that there was not a control group to see the effect of instruction. In addition, the teacher was an inexperienced teacher for implementing the problem solving activities. Hence, students might not involve actively in problem solving sessions. They might not interact with each other or reflect their thoughts to their peers during the implementation. Moreover, some students got bored while answering the questions of tests especially in post-tests, because post-tests were conducted in the last weeks of the school where students' motivation was generally low.

CHAPTER II

REVIEW OF THE LITERATURE

The purpose of this research study is to analyze the change of sixth grade students' mathematical problem solving ability after mathematics instruction based on Polya's problem solving steps. In addition, it is to seek whether there will be a change in students' attitudes towards mathematics and mathematical problem solving after mathematics instruction based on Polya's problem solving steps.

This part put lights on literature about problem solving and reform based curriculum. The literature part consists of the four main titles: Theoretical Background of the New Curriculum Study, Definition of Problem Solving, Problem Solving Approaches in Various Countries, Problem Solving Approaches in Turkey and Attitudes towards Problem Solving and Mathematics. This research was conducted considering new curriculum standards. Therefore, there is clearly a need to understand the theoretical background of new adapted curriculum.

2.1. Theoretical Background of the New Curriculum

Constructivism is a theory of learning used in education laid a foundation by Piaget in 1973 (Sert, 2008). Piaget claimed that students must build or construct their own knowledge through experiences from their life (Clark, 1999). For a meaningful learning, students must transform the knowledge to new situation for cognitive development.

According to the Vygotsky, similarly Piaget's approach, but stresses on language and culture reflecting the outside real life of students to make a meaningful learning (Popkewitz, 1998). Babadoğan & Olkun (2005) affirms

Turkish curriculum reform is based on "constructivist" theory in educational perspective. Constructivist framework challenges teachers to create environments in which they and their students are encouraged to think and explore. This is an inevitable change in education for Turkey in the process of integration to EU nowadays.

According to the Sert (2008), constructivism supplies students to reach, regenerate and build knowledge by their own thinking process. Students access the goal of the learning by their own understanding with the activities in the classroom. The learner also engages in problem solving with collaboration of other learners or individually with the guidance of the teachers.

Like in the constructivism, in the context of the new curriculum, one of the individual fundamentals of the curriculum is to make an environment for children to construct the solutions to scholastic and real life problems; in properly, the new curriculum gives emphasis on the identifying those problems and developing the proper strategies in solving them (Koç, Işıksal & Bulut, 2007). Students share their thoughts with the other students cooperatively besides that they use their language ability while explaining. Findings of Bulut (2007) showed that students started to accomplish their work in their classroom by sharing, living, doing, and understanding.

In addition, in this study, although the curriculum based mathematics instructions were applied in the classrooms with larger population, the students were in contact with each other and work either with groups or individually during activities. Moreover, the study claimed teachers though that learning was not temporary for students, in contrast, the students worked by their own to do activities or solve the problems related to their daily lives. Teachers gave projects and performance homework besides the exams where they could observe the process and students improvement through problem solving.

2.2. Definition of Problem Solving

Problem solving an important part of mathematics teaching at all levels (Posamentier, Smith & Stepelman; 2006). NCTM (2000) defines the problem solving as to "develop a deep understanding of concepts and methods by trying of problematic tasks where the mathematics to be learned is embedded" (p. 270). Martinez (2008) describes problem solving as process of reaching to an aim without knowing a definite way. He also claims that the solver can not "know previously how to do so" for the process. Schoenfeld (2007) also defines problem solving as engaging with the problems which have not a specific solution strategy. Schoenfeld also added that in problem solving sessions, there is a stress on "practicing of doing mathematics to develop sense of discipline" in mathematics (1980, p.53). In addition, Polya states the problem solving as thinking, involving, exploration, finding pattern, and mathematical thinking (Hadaway, Fernandez & Nilson, 1993).

In this study, the problem solving sessions were done by using the Polya's problem solving steps which is accepted as strategic approach recommended for mathematics problem solving. In spite of most critics to Polya, the reasons why that method was chosen were that the students make the problem meaningful reading and summarizing with their own words and the steps includes posing of a problem exist at the end of the part named as extension of the problem. Polya used problem solving techniques to enable for students to use their exploration, investigation and demonstration skills with higher capacity (Hatfield & Bitter, 2004). Wilson, Frenandez and Hadaway (1993) mentioned that application of Polya's problem solving steps in problem solving is a way to involve students in thinking process. They add that to make problem solving effective it is need to arrange the mathematics knowledge. Polya in 1957 stated the problem solving strategy extensively which consists of understanding the problem, creating a plan, implementing the plan, check and extension of the problem solving (Chamot, Dale, O'Malley, Spanos, 1992). Those four steps were extended to five steps with the integration of "extension"

part. The Problem Solving Steps of Polya were summarized from Eggen and Kauchak (2001). The steps were given in the table 2.2.

Table 2.2 Problem Solving Steps of Polya

Polya's Problem Solving Steps	**Expansion of the Steps**
Understand the Problem	• Write unknown and data. • Identify the case and determine the situation. • Clarify whether the situation suitable • Satisfy the data and unknown. • Separate different parts of the situation. • Note down suitable notation.
Creating a Plan	• Discover the relationship between the data nd the unknown. • Think of a plan for the solution • Check whether you have seen the problem efore. • Use the appropriate strategy among the trategies working backwards, finding a pattern, dopting a different point of view, solving simpler roblem, considering extreme cases ,making a rawing, guessing and testing, making listing, ogical reasoning, organizing data.
Implementing the Plan	• Solve the problem according to the strategy
Looking Backward	• Check each step. • Control whether your solution correct or not.
Extension	• Write or pose a similar problem.

In order to apply the steps, the strategies should be used in the problem solving. Hatfield and Bitter (2004) stressed that the strategies not only help students making progress in solving more challenging and hard problems but also they present chances to develop everyday use of problem solving. They also advised teachers to learn and use the strategies in problem solving. These strategies are logical reasoning, intelligent guessing and testing, extreme cases, accounted all possibilities, adopt a different point of view, visual representation, organizing data and working data (Charles & Lester, 1984).

Logical reasoning is thinking process to do proof and disprove of a statement. Students use their reasoning to find the answer without doing algebraic operation by the help of this strategy, so they do not waste time in doing operations. Intelligent guessing and testing refers to guessing and trying processes in order to check the probable conditions. For example; if the students try to find the two positive integers that differ by 1 and their multiplication is equal to 12. They can find factors of 12 then they choose two integers whose difference equals one. In extreme cases strategy, problem solver takes maximum and minimum conditions or points by making one variable as constant. They can see the effect of each case. Accounting for all possibilities implies to consider all conditions or instances to look for the most suitable one. When solving the probability problems, it make easy for students to note down all possible events. Adapting a different point of view means thinking of a problem from different points. For example, to find the time that 9 cats catch 9 mice when 3 cats catches 3 mice in 3 minutes, it can be more helpful for students to think each cat catches a mouse in the same time. In solving a problem by visual representation strategy, it is obvious that drawing figures or geometric shapes assists students to see the related connections in the problems. In set problems, drawing figures show the connection clearly for students, even they can solve those kinds of problems on the figures. Organizing data as last strategy enables students to make and use the lists of given and data. If students find the winner by counting lost and gains scores for

each contestant among three ones, it can be useful in calculating the scores by making a list of data for each person.

After definitions and problem solving strategies, in the next part it will be discussed of problem solving approaches in various countries.

2.3. Problem Solving Approaches in Various Countries

There have been reforms on educational system involving mathematical curriculum and the aim of these reforms is to make students to think critically, rationally and to use reasoning skills, to involve in learning actively and to teach the basic concepts and facts not to be transposed to knowledge directly (Anderson and Ronald, 1994). The recognition of the importance of the problem solving as key component of the educational reform has grown considerably over the past decade (Nickerson, 1994). In the context of mathematical curriculum, problem solving can be regarded as an important and considerably larger part of teaching of mathematics. For that reason, several research studies are performed about problem solving in mathematical context. Especially problem solving strategies and approaches are analyzed to meet students' challenges for pursuing higher education (National Educational Goals Panel, 1997). Thus, the requirements with the developing technology bring about new ideas and new strategies to problem solving. Generally, the purpose is to create and continue refinement of sophisticated models or ways of interpreting the situation of teaching, learning and problem solving (Xin, 2005).

Research studies on problem solving in various countries were popular in the literature. In France, a study was conducted by Artique and Houdement (2007) to understand the relations between didactic methods and curricular choices in mathematical problem solving. According to Artique and Houdement, didactic approach enables students' just mathematical knowledge and not plays role on development of students' problem solving skills. The curriculum that includes problem solving part in broader context is an

important issue for progressive change in problem solving (Artique and Houdement, 2007). The research concluded that the teachers trust in textbooks and lesson plans specified in the curriculum. They observed the problem solving sessions in the classrooms and they concluded that an effective curriculum which should let students construct their own knowledge and should enable making the sense with them in that process.

According to Boero and Dapueto (2007) problem solving had become part of the mathematics education. They stated that Italian educators in 1960 and 1970's were mostly concerned with cultural and social aspect in mathematical teaching. The Italian educators took into cognitive issues and theoretical reasoning which leaded to make predictions for making meaningful learning in mathematics (Boero & Dapueto, 2007) and continued with Polya's problem solving approach. In 1979, some Italian researchers who were members of National Commission contributed to problem solving part as an important part of mathematics to their own National Curriculum with problem solving activities including real life situation (Boero and Dapueto, 2007). Since 2000, the problem solving has improved in some fields covering the "problem solving, problem posing" in various kinds of Italian schools and schools used the textbooks developed according to the Italian National Program (Boero & Dapueto, 2007).

In England, Hell and Burkhardt (2007) states that the problem solving started to develop by presenting the "non-routine problems" and practicing tool as exercises in 1947's. This was integration of basic and complex mathematical reasoning for training teachers. In 1986, Near Future England has been using the "functional Mathematics" which means problems arising or constructed from the life in mathematics teaching (Hell & Burkhardt, 2007). The Organization for Economic Co-operation and Development (OECD) Programme for International Student Assessment (2003) suggests that each student constructs their own the way of exploration of mathematics to see part of the life; each student understands and internalizes mathematics with the frame of individuals needs**.**

Paralel to England, German researchers; the Reiss and Törner (2007) stresses German approach that is based on making sense in problem solving. They gave importance Gestalt theory that underlies the thinking process for active participation in problem solving. They also gave examples from the book of Wertheimer, which is "Productive Thinking" in problem solving: when an area of parallelogram is to be found from the area of rectangle that is an evidence of difference between proof and understanding of a problem (Lewis, 1988). After 1980's, Germans researchers claimed the new concept part of active learning as dynamic structure of problem solving steps by developing the new technology (Reiss and Törner, 2007). In German schools, Reiss and Törner (2007) defined that the curriculum was composed of "useful and practical" problems as explicitly mentioned in the curriculum and basic heuristic statements on problem solving are used in accordance with Polya. The experiment showed that these methods may result in an improved performance in problem solving but need not do so in either case. They also stated that the German elementary education system preceded the steps inclined by real life challenging problems, and stressed on students' active engagement in the process that is a constructivist approach.

Likewise England and German approaches, Netherland researchers supported integration of real life cases to mathematical problems. Doorman, Drijvers, Dekker, Heuvel, Lange, and Wijers (2007) stressed on real life mathematics in Netherlands. However, they claimed that the textbooks do not reflect this situation. They did not give importance to problem solving in primary classrooms (Doorman et al., 2007). The researchers pointed out a study which was applied to fourth grade high achiever students. The test was composed of 15 problems and applied to 152 Dutch students. The important point in the study was that even though there were extra empty pages for students to write down their process of problem solution, two thirds of the students could not use their empty pages and they did not reflected any points to their pages. In addition, only a quarter of the students were able to find the result. At the end of the post-tests, three main results were found: students did

not attempt to write solution process, students could not feel the self-confidence to start problem, and students can not struggle when they faced with the hard problems. The main result of the study was that students did not think well when they were solving the problems. Doorman et al. (2007) stated the approach to problem solving in secondary schools. They also suggested that Dutch Secondary Schools gave much importance to the problem solving skills and submitted more time for students to engage in problem solving.

Besides the type of problems and time, Hungarian researcher Szendrei (2007) claimed teaching problem solving strategies was another factor to make students engage in problem solving. The researcher retrieved that if some strategies about the solution of the problem were given before the problem solving session, students succeeded in dealing with problems more effectively. In addition, he continued that the main contributions to problem solving was done by Varga's experimental studies which made the mathematics enjoyable by real life examples and activities contributed to students the feeling that problem solving was not a fear in mathematics.

In addition to European countries, Cai and Nie (2007) studied the problem solving in China in the perspective of research and practice. They stressed more on Chinese students' problem solving skills and computation skills which means ability to evaluate result of a problem. Cai and Hwang (2002) also gave importance problem solving with a study to investigate generalized and generative thinking in 155 sixth grade students' problem solving and posing. The result revealed that Chinese students used more abstract strategies and symbolic strategies rather than concrete ones in problem solving. However, China is on the process of curriculum reform nowadays and one of the aims of the reform is to create open-ended problems from the real the life. In Chinese classrooms, teachers use the problem solving activities in their classrooms and %82 of the teachers prefers to solve only one problem. In addition, different solutions to a problem explained as variations to be able think with all aspects of the problem and to able to develop algebraic and arithmetic thinking skills (Cai and Nie, 2007). Chinese researchers were

affected by the Polya's problem solving strategy that was derived from his book of "how to solve it". The book translated into Chinese language informed the Chinese educators about the problem solving strategies.

According to the Hino (2007), Japan Society of Mathematical Education has held problem solving in their regular meetings since 1955. As Hino stated there had been improvements on mathematical problem solving with respect to real life cases, researching real life cases, process and steps of problem solving and mathematical representation. In Japan, the studies about problem solving have been conducted on the subjects of problem solving, process of students, problem solving strategies and their mathematical thinking (Hino, 2007). He also claimed that difficulties in problem solving were solved by examples and problems from real life. The Japanese researchers tried to support that the real life situation and real life cases in problem solving are needed to resolve difficulties in problem solving. Besides presenting real life examples, teacher should give students the chance to show their solution methods in front of the classroom. By this way, different kinds of solution methods come out from the original source that is from students (Hino, 2007). At the end of the lesson, students identified the ideal solution method among the other methods and write down their ideas about the one lesson hour session and problem solving as summarizing part.

To summarize, instruction based on activities involving students' school and out of school life examples, using manipulative, and solving real life problems and teaching problem solving strategies had positive effect on students' problem solving skills after examining problem solving process and approaches reflected in different countries.

Problem solving has been important part of mathematics curriculums over the developed countries (Altun, 2000). It has also crucial role in understanding mathematics in newly developed Turkish Curriculum (Işıksal et al., 2007). However, there were few studies conducted in Turkey related to problem solving and its teaching.

2.4. Problem Solving Approaches in Turkey

Töre (2007) conducted a study to investigate sixth grade students' knowing and applying level of problem solving process by the help of Polya's problem solving steps. The sample of the study was 30 sixth grade students from both private and urban public schools. Observations, interviews and problem sheets were used to measure students' level of learning and applying skills. Students were asked individually how they solved problems and which steps they applied for problem solution in the interviews. Although students in public schools rather in private schools explored that making a plan for problem solving process was an obligation for a correct solution, in application it was seen that most of the students did not use the steps and strategies in their sheets. As a result, % 50 of the students in urban public schools solved the problem correctly. However, % 20 of the students who did not make a plan or did operational mistakes did not solve the problems completely. The other finding revealed that % 30 of the students was checked the solution. The students who realized mistakes in checking process could make some corrections. The reason why the most students made mistakes in problem solving process was that most students did not pay attention to Polya's first step of reading and understanding of a problem. The last finding could be reported that when students wrote similar problem, they did not use the creativity for posing a problem. The study suggested that when problem solving process was internalized, most students solved problem correctly.

In addition to the first step of Polya, Akay (2006) conducted a study to examine effects of the last step on problem solving skill. Properly, it was to analyze the effects of mathematics instruction with last step of Polya's heuristics approach named as "posing problem" on students' academic achievement, problem solving ability and creativity. This experimental study was measured by the achievement scale, problem solving inventory scale and creativity scale with the involvement of 79 first year university students at the Science Education Department. The findings of problem solving inventory

showed that mathematics instruction with problem posing had significant positive effect on students' problem solving skills. In addition, the result indicated that students' academic achievement had increased in experimental group who were taught by the usage of problem posing approach in science course.

There were also studies related to other heuristics methods or steps of Polya. In the creating a plan step, the strategy selection played important role in that they might aid to student to solve challenging problems in a clever and simpler way. Çalışkan (2007) carried out a study to investigate effects of problem solving strategies on achievement, applicability of strategy and problem solving performance of 77 university students' in physics. Students in experimental group were taught by Polya's problem solving strategies. The findings showed that teaching of problem solving strategy had also positive effects on students' problem solving performance and achievement in physics. Moreover, findings revealed that there was positive correlation between achievement and strategy application.

Yazgan and Bintaş (2005) also conducted a study to investigate 4th and 5th grade students' problem solving abilities after using Polya's problem solving steps in their solutions. The study was an experimental study conducted with 56 students and in order to measure students' problem solving strategies pretest, retention and posttest were applied. The tests were problem solving tests composed of 10 questions. The experimental group composed of 28 students who were trained on using problem solving strategies during 12 lesson hours. After six lesson hour problem solving sessions, the results pointed that there was significant positive effect of problem solving instruction using Polya' steps on students' problem solving achievement. The findings also showed that there was an increase in 4th grade students' usage of writing a simpler problem, working backwards and drawing figures strategies. Moreover, after the implementation, result revealed that there was an increase in 5th grade students' usage of writing a simpler problem, making list, working backwards and drawing figures strategies.

In addition to problem solving strategy, Öztuncay (2005) claimed that the implication of mathematical curriculum standards was important for students' success. The curriculum standards cover cooperative learning that is an effective way of learning in the classroom (Alkış & Avşar, 2007). The standards also include individual learning in classroom environment. He conducted a study to analyze the effects of implementation of curriculum standards on mathematical achievement. The study was experimental study based on pretest and post-tests that were conducted with 44 sixth grade students in Istanbul. The experimental group was taught according to the curriculum standards whereas control group was taught by direct instruction. The result of the study showed that teaching according to the new curriculum standards has significant effect on students' achievement. Similar to Çalışkan, he also found that problem solving teaching was effective on fulfillment of the aims of the lesson. The study suggested that students knew and applied the strategy for enhancing the creativity and problem solving skill.

Similar to Öztuncay, Koç (1998) carried out a study to find effects of different teaching methods on problem solving ability. Specifically, study aimed to investigate effects of cooperative learning and individualistic learning methods on seventh grade students' problem solving performance. Koç (1998) applied problem solving performance test as pre-test and post-test to find out the difference in students' mathematical problem solving performance. This experimental study consisted of two experimental groups: one of which was taught by cooperative problem solving method based on Polya's problem solving steps during three weeks. The other group was taught by individualistic problem solving method during three weeks. The groups were composed of 25 and 24 students respectively. On the other hand, the control group consisted of 30 students were taught by traditional method. The result revealed that students working cooperatively or individually in the classroom had displayed better problem solving performance compared to the students in control group. In addition, two experimental groups notably put into practice the creating a plan part which was Polya's problem solving step contrary to the control group.

One of the aims of the study was to seek the changes of sixth grade students' problem solving abilities after mathematics instruction based on Polya's problem solving steps. These studies highlight that using Polya's problem solving methods and the way of application into mathematics lesson had important role on students' problem solving skills. Given the importance of teaching of the methods, it is seen that more studies should be conducted on problem solving methods.

2.5. Attitudes towards Problem Solving and Mathematics

In this study, it was not only aimed at investigate changes of sixth grade students' mathematical problem solving abilities after mathematics instruction based on Polya's problem solving steps; it was also to examine the changes in students' attitudes towards problem solving and attitudes towards mathematics after mathematics instruction based on Polya's problem solving steps. In that aspect, next section was based on research studies related to attitudes toward problem solving and mathematics. Attitude toward mathematics and problem solving according to the Haladyna, Shaughnessy and Shaughnessy (1983) is positive or negative emotional tendency toward mathematics and problem solving. Törner and Sriraman (2008, p.199) describes the attitude toward mathematics as "pattern of beliefs and emotions associated with mathematics".

In other countries, Lester (1978) and Stengel et al. (1978) conducted the studies to investigate the applicability of the teaching of sophisticated problem solving strategies at the age of 9 to 12 year students (cited in Silver, 1985). Silver (1985) stated that these researchers obviously showed that those students could learn applying the strategies in solving the problems. He continued that these researchers found if teacher had modeled the strategies and had made students used in problem solving, then students did the problem solving well. The students felt good about the achievement and problem solving. However, it was observed that students had difficulties in selecting proper strategy.

Posementier, Hartman and Kaiser (1998) conducted the research to investigate middle school students' problem solving skills. They founded students had difficulties in solving the problems when enough time was not allotted to students to apply planning the problem solving. They stated that students tried to solve the problems without they carried out a plan. Students began to do operations with numbers in the problems after reading the problems. Students who planned their solutions performed a better result for the solutions according to the students who solved in traditional way. They thought and studied over the problems less according to the students who did not plan for the problems. In addition, students who taught the problem solving strategies saw the procedure, concepts and algorithms and they comprehended where, when, why and where to apply (Posementier, Hartman & Kaiser, 1998, p.3). They also claimed that word problems that were meaningful to students made students use their existing knowledge and enjoy the solving the problems. A four-year case study was performed to investigate the role of preparing probable problems that was to be solved by the students. The result showed that their achievement and attitudes had significantly correlated with those kinds of problems (Posementier, Hartman & Kaiser, 1998).

In Turkey, there were studies conducted to investigate students' attitudes towards problem solving by the mathematics instruction based on Polya' steps. Babadoğan and Olkun (2005) conducted a study to report the new curriculum changes in Turkey. He revealed that that newly adapted curriculum had important role on enacting knowledge to a case or a situation or transforming their knowledge into existing problems in their life. He specifically claimed that new adapted curriculum aimed at students' active participation in learning both individually and cooperatively. They also noted that the emphasis in new curriculum was more on students' interest in learning of mathematical concepts and was encouragement to have positive attitude toward mathematics covering problem solving.

Gök (2006) supported these findings with the study that investigates the effects of teaching of cooperative problem solving strategies on tenth grade

students' achievement, achievement motivation and attitude in physics during 2005 and 2006 academic years. There were 25 students in experimental group and 21 students in control group. Experimental group solved the problems according to the cooperative learning strategy whereas the control group was instructed with traditional method during six lesson hours. One of the results of this study indicated that teaching through problem solving strategies had positive effect on students' attitudes towards problem solving.

Likewise, Yavuz (2006) investigated the effects of problem solving strategies on students' attitudes towards mathematics and academic self-concept in problem solving as well as mathematical achievement and mathematics anxiety during 2005-2006 academic years. This experimental study was performed with sample of 32 tenth grade high school students from a college and a public school during eight weeks. As a result, teaching of problem solving strategies had positive effects on students' attitudes towards mathematics and their self-concepts in problem solving. However, it was stated that there was no effect of teaching of problem solving strategies on students' anxiety through mathematics.

Bulut (2007) carried out a study to analyze the effects of implementation of new adapted mathematics curriculum submitted the sights of 5^{th} grade students and elementary teachers. The study analyzed the curriculum implementation in terms of three dimensions: namely; classroom management, instruction, weaknesses and strengths dimensions. This qualitative study consisted of forty-three fifth grade students and three elementary teachers from one primary school in Ankara where the pilot study was implemented during 2005-2006 academic years. He made semi-structured interviews with the teachers to learn their thoughts about implementation and curricular change. The interviews included six open ended and three demographic questions. In addition, an interview with the students consisting of one open-ended question was made to reflect the changes caused by the adaptation of the new curriculum. The study revealed some important results to be considered. He stated that students participated in learning with activities, materials enhancing

motor skills, self-exploration, reasoning and thinking process. The results revealed that not only students increased their mathematical achievement, but also they participated in lessons actively by the help of real life examples and the activities. In addition, results revealed those students' problem solving and posing skills developed by solving many problems via materials during that process. Moreover, students' self-expression and interaction with peers improved during the lessons and they were dealing with more on the problems according to the previous years. To sum up, the result revealed that their attitudes towards problem solving, mathematics and mathematical achievement increased by the reform based instruction.

Tural (2005) supported the previous study with a research conducted to investigate effects of instruction with games and activities in the context of reform based mathematics curriculum on twenty-six 3rd grade students' mathematical achievement and attitudes towards mathematics. The experimental group was taught with the games and activities whereas the control group was instructed with traditional way during five weeks in 2004-2005 academic years. As instruments, achievement test and attitude scale towards mathematics were used as pre-test and post-tests. The findings showed that experimental group had significantly higher scores than that of control group in terms of their attitude scores.

Kaban (2006) conducted a study to investigate the effects of the third, the fourth and the fifth grade textbooks on 721 students during 2004 and 2005 academic years. He collected data with questionnaire applied to teachers, questionnaire applied to students, mathematics attitude scales applied to students. The result of the study reported that the mathematics lessons supported with activities and real life problems were enjoyable for the 85 percent of the students participated in the study. In addition to this result, findings showed that activity based teaching and solution of real life problems during the lessons increased students' problem solving ability and attitude towards mathematics. In the study, it was reported that 75 percent of the teachers observed an increase in interest to mathematics lessons. Moreover, 73

percent of the students pointed out that lessons provided with activities and with the usage of different teaching methods were more understandable for them. From the perspective of the teachers, findings of the study reflected that activities in the context of implementation were difficult to apply in crowded classrooms.

In this part, the research studies in various countries and Turkey were discussed in details. However, there are fewer studies related to problem solving which new curriculum emphasis on. In light with literature review above, the aim of this study was to investigate the effects of reform based mathematics instruction on sixth grade students' problem solving abilities. In addition, it was aim to examine students' attitudes towards problem solving.

CHAPTER III

METHODOLOGY

The goal of this chapter is to describe the method of inquiry. More specifically, this chapter includes research design of the study, the population, sample, variables, measuring instruments being used, validity, reliability, and data collection procedure. These are followed by the context of implementation and data analysis procedure.

3.1. Research Design of the Study

The purpose of this study was to analyze the changes of sixth grade students' mathematical problem solving ability after mathematics instruction based on Polya's problem solving steps. In addition, it is to seek whether there will be a change in students' attitudes towards mathematics and mathematical problem solving after mathematics instruction based on Polya's problem solving steps.

The study was an experimental study with no control group named as weak experimental study.

3.2. Sample and Population

Convenient sampling procedure was used to select the participants of the study. The school was selected conveniently because researcher was working there. There were six 6^{th} grade classes which researcher was teaching regularly as a teacher and one of them namely 6-A constituted the experimental group of the study. The 6-A class was selected randomly as experimental group among other six 6^{th} classes. It was composed of 53 sixth grade students. The 38

percent of the class was female and 62 percent of it was male. There was no control group because all other classes also followed the new curriculum textbooks including Polya's problem solving steps. The distribution of sample related to gender was seen in the table 3.2.

Table 3.2. The Distributions of Sample Related to Gender

Gender	Experimental Group	
	Number	Percent (%)
Female	21	40
Male	32	60
Total	53	100

The school where the study conducted was the most crowded school in district of Kağıthane. It placed in one of the urban areas in Istanbul. The mathematical grades of the students were low in general. Moreover, students have low socio economic background according to the school administrators and the teachers. The school had 3280 suburban students during 2006-2007 school years. The size of classrooms was ranged from 40 to 64.

The population of the study was all 348 sixth grade students at the school. The sample was composed of 15 percent of the population.

3.3. Measuring Instruments

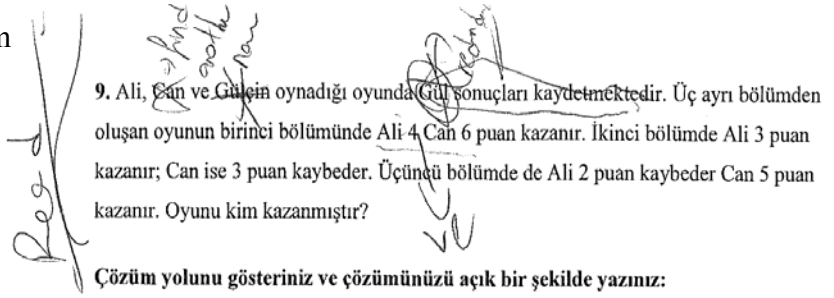
In this study, Mathematical Problem Solving Test (PSOT), Problem Solving Attitude Scale (PSAS), and Mathematical Attitude Scale (MAS) were administered as measuring instruments. In the following section, these instruments are described in details.

3.3.1. Problem Solving Test (PSOT)

The Problem Solving Test (PSOT) covers four chapters namely, numbers, geometry, measurement and algebra. The test was prepared by the researcher with the help of the books which were "*İlköğretimde Etkinlik Temelli Matematik Öğretimi" (*Olkun & Uçar, 2004) and "*6-8th Grades Mathematics Teaching Program"* (MEB, 2006). Two elementary mathematics colleagues at the same school and one elementary mathematics teacher at a private school revised the test. The test items included 24 open ended and 1 true false questions before the pilot study.

The pilot study of PSOT was administered to one of the randomly selected class with the size of 62 sixth grade students at the same school. The aim of the pilot study was to determine whether students could easily understand the questions. In addition, it was aimed to identify whether the questions were proper to their grade level. Time duration was 80 minutes that corresponds to the two lesson hours. After pilot study, grammatical structures of some questions were checked and revised by the help of a mathematics educator from Department of Elementary Mathematics Education at Middle East Technical University. The changes of a problem were shown as an example in the Table 3.3.1. In the problem, names of players were changed and the person who recorded the scores in the problem was omitted.

Table 3.3.1.1 The Changes of a Problem

The first draft of the problem	 **9.** Ali, Can ve Gülçin oynadığı oyunda Gül sonuçları kaydetmektedir. Üç ayrı bölümden oluşan oyunun birinci bölümünde Ali 4 Can 6 puan kazanır. İkinci bölümde Ali 3 puan kazanır; Can ise 3 puan kaybeder. Üçüncü bölümde de Ali 2 puan kaybeder Can 5 puan kazanır. Oyunu kim kazanmıştır? **Çözüm yolunu gösteriniz ve çözümünüzü açık bir şekilde yazınız:**

The Table 3.3.1.1 (continued)

The final draft of the problem	Ali, Burak ve Emel bir oyun oynamaktadırlar. Üç ayrı bölümden oluşan bu oyunda, oyunun 1.bölümünde Ali 4 ve Burak 6 puan kazanır. İkinci bölümde Emel 3 puan kazanır, Burak ise 3 puan kaybeder. Üçüncü bölümde ise Ali 2 puan kaybeder ve Burak 5 puan kazanır. Oyunu kim kazanmıştır?

Furthermore, five questions were converted to clearly stated ones with agreement of the elementary school teachers and the mathematics educator. As an example, a problem was also given in the Table 3.3.1.2 as before the conversion and after the conversion. In the problem, the park area transformed to a garden of a school. Whereas it was asked to find the only area of the park before the conversion, it was asked to find both area and perimeter of the school after the conversion. Moreover, the language of the problem was clearer after the conversion.

Table 3.3.1.2 The Conversion of a Problem

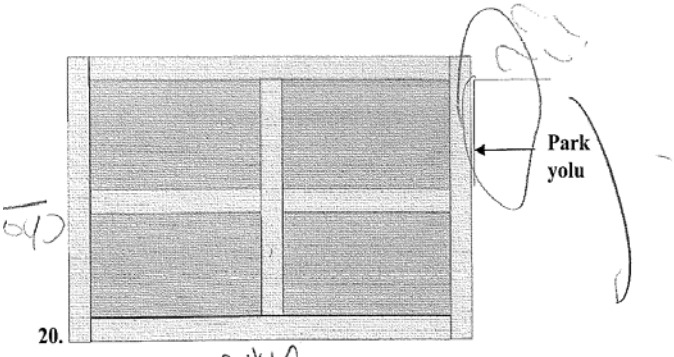
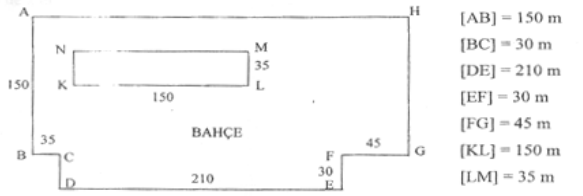
Before the Conversion	 **20.** Yukarıda bir şehir parkının yüzey alanı verilmiştir. Bu park 100 metre uzunluğunda 150 metre genişliğindedir. Park yolu ise 6 metre genişliğindedir. Park yolunun kapladığı yüzey alanını bulunuz. **Şekil üzerinde gösteriniz çözümünüzü açık bir şekilde yazınız:**

Table 3.3.1.2 (continued)

After the Conversion	1. Bir okul bahçesinin planı aşağıdaki gibidir. **Şekli kullanarak soruları yanıtlayınız Çözümünü açık bir şekilde yazınız.**  [AB] = 150 m [BC] = 30 m [DE] = 210 m [EF] = 30 m [FG] = 45 m [KL] = 150 m [LM] = 35 m a) Okul bahçesinin çevresi kaç metredir? **Çözümünü açık bir şekilde yazınız.** b) Sadece okulun alanı ne kadardır? **Çözümünü açık bir şekilde yazınız.**

After necessary revisions and deletions, 21 items were left and the test turned to PSOT (see Appendix A). As an example, the question 2 of PSOT was given in the Figure 3.3.1.

2.

Adet	**Ürün**	**Fiyat**
2	Ekmek	35 Ykr
2	Süt	150 Ykr
6	Yumurta	15 Ykr
3 paket	Vanilya	25 Ykr

Burcu**.** yukarıdaki alış veriş listesinde fiyatları ve adetleri yazılı olanları alacaktır. Burcu, alış verişe giderken yanına 4,5 YTL para almıştır. Bu para listedekileri almaya yeterli mi, değilse daha ne kadar gerekir?

Figure 3.3.1. The Question 2 of PSOT

The problem solving test (PSOT) content related to six common abilities compatible with the new curriculum standards were given in the Table 3.3.1.3. The table of content was checked by an elementary mathematics teacher from a different school and the mathematics educator.

Table 3.3.1.3 PSOT Content related to Common Abilities of the New Curriculum Standards

	Logical Induction and Deduction	Connection	Reasoning	Estimation	Ability of problem solving and posing
Numbers	4, 7		9, 19	4, 7, 10	6, 16, 17, 21
Sets		20			3, 20
Fractions	13	14	4		
Integers			13		13
Equations					9, 21
Decimal Numbers	4				2, 3
Rate and Ratio					9
Measuring					6, 21
Ordering and Probability			14, 15		12
Angles					8
Tables and Graphs		11	20		18

Table 3.3.1.3 (continued)

Patterns and Tessellation		12
Factorization		16
Polygons	14	1, 4, 5, 9

Each question of PSOT was rated over 5 points and thus the highest score that could be obtained from the test was 105. As suggested by Lester and O'Daffer (1987), holistic scoring was used while calculating the mathematical problem solving abilities of students. In holistic scoring, student's answers scored by considering the whole test. A template for holistic scoring was seen in Table 3.3.1.4.

Table 3.3.1.4 Template for Holistic Rubrics

Score	Explanation
5	It reflects complete understanding of the problem. Student demonstrates Polya's steps: 1. Understand the problem, 2. Devise a plan, 3. Solve the problem, 4. Check the problem, 5. Extension.
4	It reflects significant understanding of the problem. That is, student answers the question using Polya's steps of "understanding the problem", "devising a plan", "solving the problem" and "checking the problem". However, students make an operational mistakes while solving the question.
3	It reflects partial understanding of the problem. Polya's problem solving steps are mostly demonstrated. Student answers the question satisfied with the steps of "understanding the problem",

Table 3.3.1.4 (continued)

3	"devising a plan" and "solving the problem". Student solves the problem incompletely, but the way of solution is correct.
2	It reflects few understanding of the problem. Student demonstrates the steps of "Understanding the problem" and "devising a plan". It also reflects the correct answer without explain the solution without using Polya's steps.
1	It reflects no understanding of the problem. Student just demonstrates few understanding of the problem.
0	It reflects students do not demonstrate any steps and do not give answer.

In order to check reliability, inter rater reliability was used in rating open-ended questions (Mujis &Daniel, 2004). Thus, before the researcher scored PSOT which consisted of open-ended questions, the ten randomly selected tests from both PREPSOT and POSTPSOT were copied in order to be scored by an elementary mathematics teacher too because inter-rater reliability means agreement of two or more scorer (Fayers & Machin, 2002). After researcher and the teacher scored the tests at the same time, Cohen's Kappa value was calculated by using SAS program to assess inter-rater reliability, because there are just two scorers (Garson, 2008). The values was coded as 0,1, 2, 3, 4 ,and 5 for each question of a student. Finally, Kappa (K) value was found as 0.82 (>.70) which meant that the there was an acceptable inter-rater reliability (Garson, 2008).

3.3.2. Problem Solving Attitude Scale (PSAS)

Problem Solving Attitude Scale (PSAS), which was developed by Özkaya (2002), was used in this study in order to measure sixth grade students'

problem solving attitudes. More specifically, this scale was used to collect data about students' feelings, experiences and attitudes towards problem solving. The PSAS is a 5-point likert type scale rating from strongly agree to strongly disagree and the test was consisted of 39 items (See Appendix B). It consisted of four dimensions as like, self-concept, anxiety and usefulness. In the scale, fifteen items displayed negative statements; the other twenty-four items displayed positive statements. Özkaya, (2002) performed factor analysis and computed 0.91 as the reliability coefficient for the scale.

For this study, PAS was piloted by administering it to 53 six grade students like other instruments. The Cronbach alpha was calculated for PREPSAS as 0.85; for the POSTPSAS as 0.90, thus reliability was satisfied with the Cronbach value.

3.3.3. Mathematical Attitude Scale (MAS)

Mathematical Attitude Scale (PAS) that was developed by Aşkar (1986) was used to measured students' attitudes toward mathematics. This attitude scale was conducted to learn about students' feelings through mathematics and attitudes towards mathematics. The test was composed of 20 items with 5-point likert scale (scored as from 5 to 1) from "totally suitable" to "never suitable" given in appendix C. In the scale, ten items reflected negative statements; the other ten items reflected positive statements.

The MAS was administered to 53 six grade students like PSAS and other instruments. In order to check internal reliability of tests, the Cronbach alpha was measured and found as 0.84 for Pre-Mathematical Attitue Scale (PREMAS) and 0.85 for Post-Mathematical Attitude Scale (POTMAS).

3.4. Data Analysis

In this study, descriptive and inferential statistics were used to analyze the data. Data collected from the samples were coded and analyzed by using SPSS 15.0 package program.

In descriptive part, mean, standard deviation, minimum, maximum scores, skewness and kurtosis values of pre-tests and post-tests of Problem Solving Test (PSOT), Problem Solving Attitude Scale (PSAS), and Mathematical Attitude Scale (MAS) were computed. Descriptive statistics showed the numerical change between pre-tests and post-tests and general opinion about the students' problem solving abilities and attitudes. This descriptive analysis was computed for the following reasons: Firstly, it was used for checking the outliers and making data clean. Secondly, it was used for finding the distribution and frequencies of the data.

After performing descriptive statistics, in the inferential statistics, paired samples t-tests were used to find whether there is a significant mean difference with respect to dependent variables namely PSOT, PSAS, and MAS scores. In order to reduce Type I error, α level was set as 0.01 according to Benferroni approach (Green, Salkind, & Akey, 2000). The other way of reducing the type 1 error was using MANOVA or ANOVA statistics to test the significance of the hypothesis. Because of small sample size, however, those analysis methods were not suitable for the study. Inferential statistics was used to test the effects of mathematics instruction based on Polya's steps on 53 six grade students' 1) problem solving abilities, 2) attitudes toward problem solving, and 3) attitudes toward mathematics respectively.

3.5. Variables

In this study, dependent variables were PSOT, PSAS, and MAS. Independent variable is the mathematics instruction based on Polya's problem solving steps.

3.6. Procedure

The purpose of this study was to analyze the changes of sixth grade students' mathematical problem solving ability after mathematics instruction based on Polya's problem solving steps. In addition, it is to seek whether there will be a change in students' attitudes towards mathematics and mathematical problem solving after mathematics instruction based on Polya's problem solving steps.

This study was a one-group pretest post-test design which had a group instructed according to the Polya's problem solving steps. After pre-tests were administered, the researcher taught to students how to use Polya's problem solving steps during the implementation. The instruction in the group was based on *İlköğretim Matematik Öğretmen Kılavuz Kitabı 6* (Meram, 2006). The mathematics textbook have been accepted by Ministry of National Education between the years of 2006-2007. In this textbook, the four chapters were part of this study. The first chapter was composed of numbers and geometry subject areas. There was one sub-subject area of natural numbers and one learning outcome in numbers subject area. Geometry learning area included 19 learning outcomes from six sub-subject areas that were line, line segment and ray, angles, polygons, equality and similarity, translational geometry, tessellation and ornamentation. Second chapter was composed of numbers, statistics, and probability subject areas. Numbers subject area consisted of six learning outcomes under two sub-subjects areas that were sets and natural numbers. Statistics and probability subject area included eight sub-subjects areas that were collecting data, tables and graphs, measure of central tendency and defining probable situation. The chapter three was composed of four subject areas that were numbers, geometry, measurement and algebra subject areas. Under these subject areas, there were integers, operation with integers, multiple factors, polygons, angles, measuring angles, tessellation and algebraic equations. Equality was defined with 17 learning outcomes in the textbook.

The last chapter included sub subject areas of fractions, decimals, rate and ratio, measuring length, measuring, central tendency, and basic concepts in probability, kinds of basic statistics and probability with eight learning outcomes.

The Problem Solving Test (PSOT), Problem Solving Attitude Scale (PSAS) and Mathematical Attitude Scale (MAS) were used in this study. The problem solving test (PSAS) was piloted and administered to the students from different six grade classes in the same school as mentioned above. The PSOT was administered as pre and post-test. Time fixed was 80 minutes for the test. Similarly, Problem Solving Attitude Scale (PSAS) and Mathematical Attitude Scale (MAS) were administered by the researcher to the group as pre and post-tests. Time allotted for each test was 20 minutes.

After the implementation of pretests, the treatment began in the following week. The treatment lasted four lesson hours in each week. Duration was 40 minutes for each lesson. Totally, treatment period lasted 78 lesson hours that corresponds to 19 weeks. During the treatment, students solved problems and performed mathematical activities according to Polya's problem solving steps. Polya's mathematical problem solving steps were taught just after being applied all pre-tests.

At the beginning of the lesson, researcher asked the students how they usually solve mathematical problems. Students reflected that they used basic operations when they faced with a problem. When researcher asked the question whether it was possible to know the sum of counting numbers up to 100, students had difficulties in finding a solution. Teacher then solved the question by using the "adopt a different point of view" strategy that was one of Polya's problem solving strategies.

$$\begin{array}{r} 1 + 2 + 3 + 4\ldots\ldots+100 \\ +\ 100 + 99 + 98 + 97\ldots\ldots+ 1 \\ \hline 101 + 101 + 101 + 101\ldots\ldots+101 \end{array} \qquad \frac{101\times 100}{2} = 5050$$

Students enjoyed this simple solution. Teacher solved the problem according to the problem solving steps of Polya. He stressed that they had to write "understand the problem" as a title first. Then, under this title, he summarized the problem: "we have sum of natural numbers from 1 to 100. In the problem, the sum of these numbers are asked." He introduced second title as "devise a plan". In that part, he stressed that they had to create a strategy in order to solve the problem. For instance, for this question they should look at the problem from different perspective and write the numbers in reverse order. Then teacher wrote the third title as "solve the problem". He solved the problem according to the strategy selected in the "devise a plan" part. Afterwards, he reminded that students should check the solution. He wrote another title that is "check the solution" and he controlled the answer by going backwards. Lastly, teacher wrote a similar problem under the "extension" title. Under this title, teacher wanted students to find the addition of even numbers up to 50 by using Polya's steps.

3.7. Context of Implementation

The study began after taking permission from the school administration. The PSOT, PSAS and MAS were piloted to the randomly selected students. In the pilot study, Problem Solving Test was applied to 62 sixth grade students in October 2006. After the pilot study, Problem Solving Attitude Scale (PSAS), Mathematical Attitude Scale (MAS) and Problem Solving Test (PSOT) were administered to the students for pretests. The timetable related to implementation was seen in the table 3.7.1. Before the application of pre-tests, the aim of the study was explained to the students briefly. At the end of three-month treatment, the post-tests of PSOT, PSAS and MAS were conducted to students satisfied with full involvement of students.

Table 3.7.1 Timetable Related to Implementation of the Tests.

Tests	PRE	POST
PSOT	Last week of February	Last week of May
PSAS	Third week of February	First week of June
MAS	Third week of February	First week of June

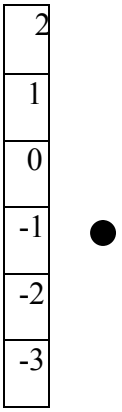
During the treatment, there were activities, performance homework, and projects for the students. These applications existed in the textbook. There were annual plans for four units at the beginning of the textbook (The plan of unit one was given in appendix D). The unit 2 contained the lesson plan for "operations on integers" and abilities of solving related the problems according to the Polya's steps (The plan was given in Appendix E). In addition to textbooks, there were also activities that were taken or developed from the book named as "İlköğretimde Etkinlik Temelli Matematik Öğretimi" by Olkun and Uçar (Samples of activities were given in Appendix F). For the teaching of Polya's problem solving steps and specifically strategies, the book "Problem Solving: A handbook for Elementary school Teachers" was used. The preparations for lessons were supported by those sources. One routine example of classroom teaching was described as follows:

The subject of the lesson was addition and subtraction with integers. The materials for the lesson were overhead projectors, newspapers, red and blue counters: blue counters assumed as they represented positive integers, red counters assumed as they represented negative integers. Before the starting lesson, the question was asked:

The temperature of Istanbul was -1 Celsius degrees today as shown in the thermometer. To the forecast news from the newspaper, there would be 2

Celsius degree increases in temperature in the following day. Could you find the temperature of the following day?

Students mostly answered as -3, but some of them responded as +1. Teacher then asked which one was correct. Teacher created an elevator from the cartoon and let the students move the circular shape upward by two degrees over this elevator. The student among volunteers moved the circular shape in front of the class by using overhead projectors. Teacher asked for the answer, most of the students would respond as +1.



After warming up question, students made groups with the peers according to their grades in the pretests. Each student in one group had the similar score in the tests. There were 8 groups and each group consisted of 6 students. They would learn the addition of positive integers by adding the blue counters, and they would continue showing operation on overhead projectors. They also had counters on their desks and they were all doing the operations. One member of each group tried to do operation with integers in front of other peers in the classroom. Here, teacher encouraged students to identify what was given and asked in the question. In addition, teacher encouraged students to generate strategies to solve the given problem.

One student could not find (-2) + (-1). Teacher simplified the situation: "You have 2 red counters and you want to add one red counters to them. How many red counters you get?" After the explanation, the student replied with easily. Then teacher wanted the students to explain what they were doing while they were demonstrating the operation. Up to that point, they constructed the

(+3) + (+4) or (-2) + (-5) easily. The teacher also demonstrated that addition of equally positive and negative integers equal to zero. He explained rule by an example; adding one red counter with one blue counter equal to zero such as (–3) + (+3). Some students asked if one blue and one red counter had to equal to zero. Teacher explained that after one blue and one red counter matched, they were anymore neither blue nor red and they represented nothing (0)". Moreover, one of the students who tried to demonstrate (-2) + (+4) could not find the result. Then, the other students wanted to reply it, but the teacher wanted that student to get help from his group members. Afterwards, he showed the matching of blue and red counters correctly. He stated that two blue counters were out of the matching and the result released as +2. Students, then, practiced more examples with their group members.

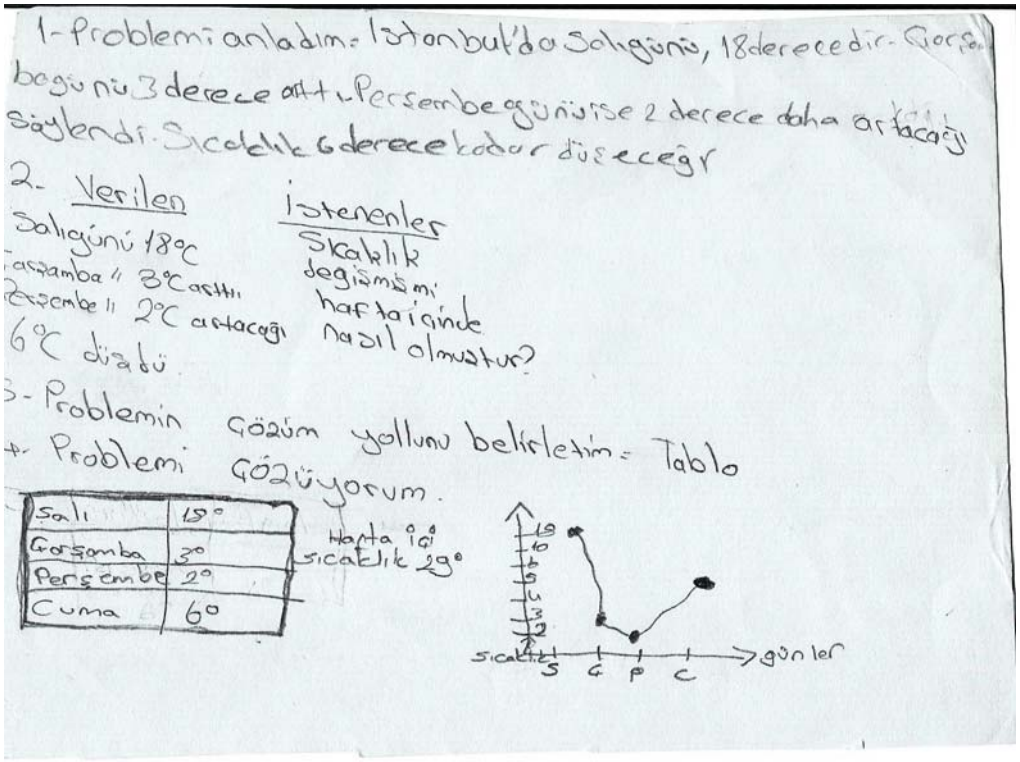
At the end of the activity, students explained the rule with their own sentences and then they noted to their notebooks with clear sentences: When doing addition in integers, blue and red counters were matched. If no counter was left alone, the result equaled zero. If blue or red counters were left, it equaled the number of counters. Some students stated that they could not write the rule with their own sentences. In order to avoid this situation, teacher would let some students read their notes and if necessary, he made corrections on the sentences. During the lesson, students practiced more examples about addition and subtraction operations of integers. They were active and eager in learning by doing operations, exploring their rule and ideas. Researcher as a teacher created an environment that students could ask questions and reflect their different ideas. In addition, researcher tried to encourage students to use Polya's step while solving the given problems.

In the second lesson, one-hour problem solving session implemented. The problems related to operations of integers had been prepared to cards (see Appendix G) by using Glencoe McGraw-Hill (2003) mathematics textbook. They were not only translated into Turkish but also adapted to Turkish Culture. For example, one of the problems adapted as: "The highest temperature in Eastern Anatolia region was recorded as about 48 degree Celsius in Kocatepe

in Mardin and the lowest temperature was about -43 degree Celsius taken from website of Devlet Meteroloji İşleri Genel Müdürlüğü (http://www.dmi.gov.tr). Find the difference of the temperatures of those places."

Students worked with their own groups satisfied with the two cards for each group. They were guided to write the problems in the cartoons delivered with the problem cards. Students asked how they cut the cartoons that they would write their solutions. Teacher showed a sample size to all class and then he warned that any group member in each group could be selected for presenting the solution. Therefore, they would be active in problem solving.

In the activity, students worked with their own groups. Each group solved the problems by trying to apply Polya's problem solving steps. In the group, some students cut the cartoon, some students read the question other student who would write on the cartoon. At the end of the preparation, group members all worked on problem solving. One of the group worksheet was shown in figure 3.7.1.



The Figure 3.7.1 related to Worksheet of a Group

Then they were asked to exchange the problem cards with other groups because it was noted that the groups who solved many problems reflected with clear solutions would see their work on the bulletin board in the classroom.

Up to that point, sample of a group working was described in details. However, there had been mostly individual working in the classroom in order to make the students internalize the application of those steps. Teacher wrote the problem on the blackboard such as: “Beden eğitimi öğretmeni 23 nisan şenliğine okuldan eşit sayıda öğrencinin katılmasını istiyor. Seçilen öğrenci grubun 5/8 inin kız olduğunu görüyor, fakat 12 tane daha erkek öğrenci seçtiğinde gruptaki kız ve erkek öğrencilerin sayısının eşit olduğunu görüyor. Bu şenlik için seçilen kaç tane öğrenci vardır?” One of the students solved the problem by making list. Teacher asked: “Why did you make a list”. She replied: “I can see the data well when I write in this way, so I can understand what is asked better”. Teacher waited until all students finished the solving the problem. He allocated 5 minutes for a problem to let students use all the steps completely. Teacher observed that some students finished earlier while he was dealing with other the students. Then, he wrote another problem in the board. After finished the first problem, teacher asked them to present their solution way on the board. One of the volunteers solved the problem by using logical reasoning. She stated, “if there are 5 girl and 3 boys, I pick 2 boys for group. Then, I divide 12 by 2, I get 6. I multiply 6 by 8 I get 48. Then, I add 12 to get number of new group.” Most of students did not understand this solution. Teacher asked students to solve the problem in different ways.

A student solved, but not correctly and found a different result. Teacher asked student: “if you say there are 3 boys and 5 girls in the group, to make equal the numbers of boys and girls, how many boys you pick.” Then, students answer it as 2. Teacher continued that: “But you have 12 boys, how many times you pick?”.The student said that it was 6 times. Teacher wanted him to complete 6 times for all group. After that, he found 6 x 5 = 30. In addition, one of the students stated: “I draw a fraction to see each part.” He used the strategy drawing a figure and showed the way with using Polya’s problem solving

steps. He missed the checking part, but teacher warned them to forget a part and other students also reminded him to write checking part. Some students implied that they could not solve if they faced with such problems again. Teacher wanted them to write a similar problem and solve in the classroom. They changed some numbers and found another event instead of 23 Nisan Celebration. A one-hour problem solving session continued with two more problems like this way. They used the strategies and steps of Polya on the blackboard, sometimes they missed some steps, but other students warned, if needed, teacher warned them to write all steps.

Instructional materials, instructional methods and techniques, projects, performance, homework were part of the teaching and compatible to instructional objectives and learning outcomes of the new developed curriculum. In that lesson, it was given importance to create an environment for students' self-exploration of themselves not only in mathematical discussion, but also in the processes of mathematical problem solving on integers.

3.8. Internal Validity of the Study

Internal Validity of a study refers to observed differences on dependent variable, but not due to the unintended variables (Fraenkel & Wallen, 1996). This study was a weak experimental study as indicated above. Therefore, there were subject characteristics, researcher bias, location, and mortality and pretest threats to internal validity. To begin with, the subject characteristics, subjects were selected from the same grade level students in this study, so their ages were controlled.

In this study, the researcher was the teacher of the experimental class at the same time, so there might be a researcher bias in implementation during not only the administration of the tests, but also scoring of them. The researcher conducted the treatment, so teacher's expectations from the students might have influence on students' performance and attitudes towards lesson and all four tests. To reduce this threat, students were explained that they were not

assessed by this test and they were noticed that results of those tests were not effective their grades.

The school in the study was selected by using convenient sampling. Thus, students were not selected randomly and there was a subject characteristics threat. In order to minimize the threat, the researcher selected a class that he did not teach and so did not interact before.

The tests were administered to the students at the same time, so location threat was controlled. In addition, there was no testing effect because in PREPSOT and POSTPSOT, numbers of questions in each test remained same. There was no change in numbers of students in the pre-test and post-test, so mortality was not a threat to this study. In addition, pretest can be a threat for this study.

3.9. External Validity of Study

External validity is extending results to general situations (Fraenkel & Wallen, 1996). The sample of the study consisted of 53 sixth grade students where the population of study was 348. The study can be generalized to all sixth grade classes at the urban schools that have the characteristics in size, social conditions. Therefore, participants constitute larger population to be extended regarding external validity. The instruments were administered under the standard classroom settings.

CHAPTER IV

RESULTS

In this chapter, the findings of the study will be introduced under two headings; namely, descriptive statistics and inferential statistics. In the first part that is descriptive statistics, means, standard deviations, skewness and kurtosis values are presented. In the inferential statistics part, paired sample t-tests were performed to answer the research questions.

4.1. Descriptive Statistics

This part shows descriptive statistics of data. More specifically, the means, standard deviations, skewness, and kurtosis values of pre and post-tests scores of Mathematical Problem Solving Test (PSOT), Mathematical Problem Solving Attitude Scale (PSAS), and Mathematical Attitude Scale (MAS) are presented.

4.1.1. Descriptive Statistic of Mathematical Problem Solving Test (PSOT)

As seen from the table 4.1.1, there was difference between sixth grade students' pre-test and post-test scores on Mathematical Problem Solving Test. The mean score on PSOT highly increased in the PSOT compared to the PREPSOT. Distribution of PREPSOT and POSTSOT scores is almost normal since the skewness and kurtosis values were close to zero.

Table 4.1.1 Descriptive statistics related to the PREPSOT and POSTPSOT scores

	PREPSOT	POSTPSOT
N	53	53
Mean	20.38	38.78
Std.Deviation	10.77	15.912
Skewness	.70	.39
Kurtosis	.66	.11
Maximum	52	80
Minimum	0	6

4.1.2. Descriptive Statistics of Problem Solving Attitude Scale (PSAS)

As seen in the table 4.1.2 below, there was a slight change among the mean scores measuring problem solving attitudes of the students. Students' problem solving scores distributed evenly in both POSTPSAS and PREPSAS. The kurtosis values were negative in both PREPSAS (-0.07< 0) and POSTPSAS (-0.42<0) as seen in the table. However, since these values were close to zero, distribution of the PREPSAS and POSTPSAS scores could be regarded as normal.

Table 4.1.2 Descriptive statistics related with the PREPSAS and the POSTPSAS of 53 Six grade students.

	PREPSAS	POSTPSAS
N	53	53
Mean	135.51	140.07
Std.Deviation	16.90	22.16
Skewness	0.39	0.57
Kurtosis	-.07	-.42
Maximum	180	191
Minimum	92	102

4.1.3. Descriptive Statistic of Mathematical Attitude Scale (MAS)

Mathematical Attitude Scale measured students' beliefs, negative and positive views towards mathematics. As shown in the table 4.1.3, the mean score from PREMAS to POSTMAS changed slightly, but in positive directions. That means sixth grade students attitude scores toward mathematics increased after the implementation. The distribution of values was symmetrical based on the skewness and Kurtosis values of PREMAS (0.89) and POSTMAS (0.09). In PREMAS, the kurtosis value was positive while it was negative in POSTMAS. This indicated that most of the students were near to average but slightly less than the average (-0. 61).

Table 4.1.3. Descriptive Statistics of PREPMAS and POSTMAS scores.

	PREMAS	POSTMAS
N	53	53
Mean	70.94	79.57
Std.Deviation	12.05	9.99
Skewness	.89	.09
Kurtosis	0.7	-.61
Maximum	100	98
Minimum	53	60

4.2. Inferential Statistics

Inferential statistics was performed in order to answer the research questions. In this research, paired sample t-tests were used to analyze the hypotheses because of small sample size. In order to minimize the Type I Error, the alpha levels were set as .01 before performing analyses.

Before starting with inferential statistics, the normality assumption was satisfied by looking at the skewness and kurtosis values. Skewness values of scores (-0.61, 0.57, 1.29, 0.39) were closed to zero. The kurtosis scores of POSTMAS, POSTPSAS, POSTMAT, POSTPSOT (-0.61, -0.42, 2.31, 0.11 respectively) scores were also not too high. Thus, these kurtosis and skewness values of the variables showed that distribution was normal and assumption was satisfied (Simon, 2002).

4.2.1. Missing Data Analysis

There were 5 missing data caused by students' unwillingness to solve the tests in classroom environment. As a result, some pre-tests and post-tests were

omitted from the data collection. Among the 58 students, 53 of them completed all the instruments used in the study.

4.2.2. The Change in Students' Problem Solving Abilities

In this part, the results related to the effects of new implemented curriculum on the students' problem solving abilities was stated for each null hypothesis.

Null hypothesis 1: There is no significant mean difference among pre-test and post-test scores of sixth grade students' problem solving abilities on numbers, geometry, measurement, and algebra units after implementation of mathematics instruction based on Polya's problem solving steps?

In order to analyze the first hypothesis paired sample t-test was applied. The results are seen in the table 4.2.2.

Table 4.2.2 The Results of Paired Sample t-test of PREPSOT and POSTPSOT

		Mean difference	St. dev.	t	df.	Sig.(2-tailed)
Pair 1	PREPSOT-POSTPSOT	-18.406	10.641	.592	52	.006

The findings showed that there was statistically significant difference between PREPSOT and POSTPSOT scores, $t(52) = 0.592$, $p < .01$. Thus, the null hypothesis was rejected. In other words, there was significant increase in sixth grade students' problem solving scores after mathematics instruction based on Polya's problem solving steps. In addition, the eta squared was calculated as 0.006 by using the formula below. This showed a small effect size in terms of practical significance according to guidelines of Cohen (1988).

$$\text{Eta square} = \frac{t^2}{t^2 + N - 1}$$

4.2.3. The Change of the Students' Attitude toward Problem Solving

Null hypothesis 2: There is no significant mean difference among pre-test and post-test scores of sixth grade students' problem solving attitude on numbers, geometry, measurement and algebra units after implementation of mathematics instruction based on Polya's problem solving steps?

The results revealed that there was not statistically significant difference between pre and post-test scores of mathematical problem solving scores of students, $t(52) = -1.44$, $p > .01$. Thus, the null hypothesis was not rejected. In other words, there was not a significant change in sixth grade students' attitudes towards problem solving after mathematics instruction based on Polya's problem solving steps. The eta squared was calculated as 0.038. In other words, analysis revealed that results have small practical significance despite the lack of statistical significance.

Table 4.2.3 The Result of Paired Sample t-test of PREPSAS and POSTPSAS

		Mean Difference	Std. Dev.	t	df	Sig.(2-tailed)
Pair 1	PREPSAS-POSTPSAS	-4.56	23.05	-1.44	52	.038

4.2.4. The Change of the Students' Attitude toward Mathematics

Null hypothesis 3: There is no significant mean difference among pre-test and post-test scores of sixth grade students' attitudes towards mathematics on

numbers, geometry, measuring, and algebra units after implementation of mathematics instruction based on Polya's problem solving steps?

Table 4.2.4. The Result of Paired Sample t-test of PREMAS and POSTPMAS

		Mean difference	St. dev.	t	df	Sig.(2-tailed)
Pair 1	PREMAS-POSTMAS	-8.62	15.48	-0.559	52	.006

As seen from the table 4.2.4, there was statistically significant difference between PREMAS and POSTMAS scores, $t(52) = -0.559$, $p < .01$. Therefore, the null hypothesis was rejected. In other words, there is a significant change in six grade students' attitudes towards mathematics after mathematics instruction based on Polya's problem solving steps. The eta squared was calculated as 0.006. This showed smalleffect size in terms of practical significance.

The inferential statistics of problem solving test, problem solving attitude scale and mathematical attitude scale were analyzed in addition to descriptive statistics in the result part. Firstly, results revealed that there was a significant mean difference between pre and post-test scores of students' problem solving scores on numbers, geometry, measurement and algebra unit after mathematics instruction based on Polya's problem solving steps. Secondly, the statistical analysis showed that there was not a significant mean difference between pre and post-test scores of students' attitudes towards problem solving on the four units after mathematics instruction based on Polya's problem solving steps. Finally, the analysis disclosed a significant mean difference between pre and post-test scores of students' attitudes towards mathematics on the same units.

CHAPTER V

DISCUSSION, RECOMMENDITION AND IMPLICATION

In this chapter, firstly the implementation of the curriculum in the classroom will be discussed. Then, students' attitudes towards mathematics and problem solving will be discussed. Finally, recommendation and further implications will be given.

5.1. The Implementation of the New Curriculum

The purpose of the study is to analyze the change of sixth grade students' mathematical problem solving ability after mathematics instruction based on Polya's problem solving steps. In addition, it is to investigate whether there will be a change in students' attitudes towards mathematics and mathematical problem solving after mathematics instruction based on Polya's problem solving steps.

There were some studies similar to this study in terms of conducted by Güzel and Alkan (2005) and Bulut (2007) revealed important findings to be evaluated and discussed. The finding of Bulut (2007) confirmed that instruction with activities, material and real life examples leaded students to participate in learning.

These findings also support the findings of Tural (2005) who found that new curriculum instruction had enhanced attitude toward mathematics instruction in a positive way contrary to traditional curriculum instruction. The reason grounded positive attitude toward new curriculum instruction might be that instruction with games, activities, material and different teaching methods aid students to take interests to mathematics lessons. During the classroom observation, it was seen that students was excited in involving the activities

and they got pleasure in doing these activities. Mathematics instruction included activities taken students' attention and interest were enjoyable for the students. This claim was supported by Akdemir (2006) who confirmed with the study that the usage of instructional tools like activities, dynamic tools for mathematics enabled students to enjoy their learning.

The other finding resulted in new curriculum implementation was that reform based mathematics instruction including problem solving based on Polya's steps increased the students' ability to solve non-routine problems indicated in mean score of Problem Solving Test. Because, the problems were taken form the books that were appropriate for the new mathematics curriculum. Students faced with different problems, but they were related to real life cases aroused students' interest and enable to think and be aware of the outside life. This result was supported with the research by Öztuncay (2005) and Bulut (2007) who reported that new curriculum instruction had effect on ability to solve the new mathematical non-routine problems.

Connection between outside of the life and mathematics might be the reason accounted for the positive effect on development in active involvement to mathematics lessons. Students might be aware of that mathematics connected with the real life. Reiss and Törner (2007) and Hino (2007) confirmed this claim that integration of practical and useful problems to mathematics teaching improved the students' active involvement and performance.

Apart from those results, Öztürk (2003) reported that learning in the crowded classrooms with inadequate materials and teaching tools was not effective. However, this study was conducted in the crowded class that there were 53 students. Thus, some activities were not so effective for the crawded classroom, because teacher had to deal with the students individually too. Besides the crowded groups, most students accomplished their tasks and understood the solution in general.

5.2. Students' Problem Solving Abilities

According to result of the study, students who were taught by reform based instruction had significantly high mean scores on PSOT. Students' problem solving skills were considerably developed according to the pre tests and post-tests mean scores ((M = 20.38, M = 38.78). The results of study supported the finding of Öztuncay (2005) who found that implication of mathematical curriculum standards was important for students' success in problem solving. Töre (2007) also supported that reform based instruction by the help of Polya's problem solving steps had positive effective on students' problem solving abilities.

There might be several reasons that enhanced students' problem solving skills by the reform based instruction. One of the reasons was that the problems related to real life might attract students' interests and deal more with problem solving in the classroom. Consistent with the Tandoğan and Akınoğlu's (2006) findings, present study revealed that when problem expressed with daily life scenarios or cases, it might lead students to participate in the sessions actively. In addition, it might enable the students to take away their worries about problem solving. Moreover, using strategies like making list, drawing figures, working backwards, making the problem simple, and guessing for solving problems could be important factors in enhancing students' problem solving and posing abilities. Results were also consistent with Özsoy's (2007) result where using metacognitive strategy of Polya's problem solving in activities increased fifth grade student's problem solving achievement. Yazgan and Bintaş (2005) also pointed out that problem solving strategies including making list, drawing figures, working backwards affected the fifth grade students' problem solving achievement. Additionally, it could be deduced that individually or cooperatively involvement in problem solving sessions according to the Polya' steps might increase the students' problem solving skills.

Another reason might be that students who were working with cooperatively or individually increased their problem solving and posing performance. They were interacting with each other and sharing their ideas for solution in cooperative working. The students who had difficulties in understanding of a problem could even suggest the way for solution. As far as concerns individual learning, students could internalize the steps of a problem by their own. That probable assertion was consistent with the result of the study conducted by Koç (1998) in that individualistic and cooperative problem solving method with Polya's heuristics strategies increased students' problem solving performance.

The other reason might be that writing extension of a problem or posing a problem as last step of Polya influenced students' problem solving skills. Students could write extensive problems by using their creative thinking. Akay (2006) supported that new mathematics instruction with problem posing was significantly effective on students' problem solving skills in a positive way. In addition, Silver (1997) reported that mathematics instruction which included problem posing task and activities could enable students to develop more creative advance to mathematics.

Another reason that increased students' problem solving abilities might be that process of transforming knowledge into solution with Polya' problem solving steps enabled students to think over problems more. Most students could write all or some partial stages of Polya's problem solving steps. By this way, students might spend more time reading, drawing, checking the solution or writing unknown. Likewise, Töre (2007) sustained that the students who realized mistakes in checking process could make some corrections. The researcher also suggested in his study that when problem solving process was internalized, most students solved problem correctly.

In addition, during the classroom observations, students stressed that they enjoyed the problems related to the social sciences that are from outside of school life. They were having fun while reading the problem or discussing the issues related to problem in the classroom. Those findings were consistent with

the result of Kaban (2005) who stated that mathematics lessons supported with activities and real life problems were enjoyable for the 85 percent of the students participated.

Finally, students' problem solving abilities might have been influenced by role of students' self-efficacy. Students' beliefs in success of solving a problem stated in the 22nd item of PSAS (Problem Solving Attitude Scale) as "I am sure that I am able to solve most of the problems". Before the implementation of reform based instruction students' mean score was 3.61 which showed that most of the results were close to "I am not sure". In post-test, the statement changed to the "I agree the statement" according to 4.07 mean score. As a result, it could be deduced that students' beliefs in solving a problem slightly increased at the end of the treatment. Students' involvement into the problem solving activities related to the daily life situations could be an important factor in increasing their efficacy belief even when they did not solve the problems correctly. Those results were consistent with the findings of Frank and David (1994) who reported that self-efficacy in mathematics has positive effects on problem solving.

5.3. Students' Attitudes towards Problem Solving and Mathematics

One of the results of the study showed that reform based mathematics instruction did not have significant effect on students' attitudes towards problem solving. However, mean score (M = 135.51, M = 140.07) showed that reform based instruction with Polya' s problem solving steps slightly increased students' attitude towards problem solving. This result supported by Gök (2006) and Yavuz (2006) who confirmed that teaching through problem solving strategies had positive effect on students' attitudes towards problem solving. This result was also consistent with the findings of Babadoğan and Olkun (2007) who reported that the main aim of new curriculum change was to set a positive attitude towards mathematics and to increase students' attention to mathematics.

The most important reason that affected the students' attitudes might be that a positive attitude toward problem solving was caused by students' active engagement in the problem solving. During the study, the well-prepared activities implemented with effective materials. This new mathematics instruction including word problems organized to gain students' attentions by presenting real life situations and making them use their motor skills by touching, playing, observing concrete materials. Students, in this study, were involved active in the lesson concrete materials and with activities addressing students' visual representation and kinesthetic interaction. Findings of Bulut (2007) supported that students' participation in lessons actively by the help of real life examples and materials increased their attitudes toward problems solving. If the mathematics made enjoyable for the students, they would not afraid of problem solving and mathematics (Szendrei, 2007).

Another reason might be that working cooperatively developed a positive effect on students' attitudes towards problem solving. Students shared their feelings with each other in the classroom settings. They tasted feeling of sharing by doing something with other peers. Gök (2006) supported this finding by the result of the study that cooperative problem solving strategies in physics affected students' abilities, attitudes toward problem solving and other motivations in a positive way. The students working cooperatively in the classroom showed positive attitude toward problem solving beside better performance in problem solving (Koç, 1998).

In addition, applying problem solving strategies into problem solving might be a reason that developed positive attitudes towards problem solving. They learnt different strategies that aided the students to view the problems from different perspectives. Yavuz (2006) confirmed that problem solving strategies had positive effects on students' attitudes towards their self-concepts in problem solving, and developed positive manner to problem solving. In this study, they tried different ways for solving problem during the problem solving sessions. They could solve the problems that they could not solve before. They saw that a problem could solve in a simple way in the lessons. Therefore, the

strategy selection played important role in that they might aid to student to solve challenging problems in a clever and simpler way (Çalışkan, 2007).

Moreover, reason that inferential statistics showed not significant change in students' attitudes towards problem solving, it might be stated that they already developed positive attitude toward problem solving. This study might contribute new problem type and new approach to problem solving for them. Another reason might be that classroom was very crowded, so the students or groups who finished the solution of problems might be bored while waiting for others. They also did not want to write all the steps of Polya especially for simple questions.

The results of this study also showed that students who were taught according to the reform based instruction had more positive attitudes toward mathematics compared to their attitudes before the implementation. In this study, there was an increase in the mean difference from PREPSOT to POSTPSOT (M = 70.94, M = 79.57). During the observations, students stressed that doing activities were enjoyable in mathematics classes. In addition, one of the students reflected that she remembered the activity done in the classroom when she answered the questions taking the exam during the implementation. Two mathematics teachers who were working at the same school observed the students while they were engaged in the activities during the study. Those teachers mentioned that students were participated in the lessons actively. In other words, they tried to write something and draw figures and shapes even they did not understand the problem. In some problems, not for all of them, they applied the Polya's problem solving steps. Parallel to this, results revealed that students' average scores on the 17^{th} item in Mathematics Attitude Scale (mathematics lesson is an enjoyable lesson) increased from 3 to 4 after the treatment. These findings showed that students' attitude toward mathematics was already average; but it can be said that with reform based instruction attitudes toward mathematics increase positively. This finding is prominent when considering the findings of Bulut (2007) and Tural (2005) who found that new curriculum instruction had positive effect on students'

attitudes towards mathematics. Babadoğan and Olkun (2005) also reported that the emphasis in new curriculum was more on students' interest in learning of mathematical concepts and was encouragement to have positive attitude toward mathematics covering problem solving.

The instruction with games and activities in the context of reform based mathematics curriculum might be a reason that had a positive effect on the attitudes towards mathematics. When students played or did activities during the lesson, they reflected more enthusiasm to mathematics lessons. Finding of Tural (2005) supported that instruction with games and activities in the context of reform based mathematics curriculum had increased their attitude scores in a positive way.

The effects of problem solving strategies might be another reason which was effective on students' attitudes towards mathematics as on students' attitudes toward problem solving. They used different methods to solve difficult problems even hard ones, by this way they could cope with their anxiety through mathematics. Finding of Yavuz (2006) supported the finding that using the problem solving strategies improved academic self-concept in problem solving as well as mathematics anxiety.

The findings of the studies which were aimed to investigate the effects of mathematics instruction on the attitudes towards mathematics supported the findings of this study. The most important result might be that mathematics connected with real life had a positive effect on students' attitudes towards mathematics. Students were not interested in mathematics except from classroom, and the reason might be thought that they could not relate the mathematics to everyday life. Likewise, Akdemir (2006) stated that students' attitudes scores were found as either negative or positive. Because they might think that mathematics was hard and useless for their present life.

5.4. Implications

In this study, it was revealed that reform based instruction with Polya' s problem solving steps had important benefits on students' problem solving skills as well as attitudes towards problem solving and mathematics. Taking into account of these reported results, it was seen that implication of Polya's problem solving steps and problem solving strategies in problem solving was not difficult to apply into problem solving. Therefore, teachers should first teach those steps and strategies and then they should develop proper activities or problem solving cards to make students solve problems with strategies by the help of Polya's problem solving steps.

One of the main contributions of these steps to learning is that some steps can be correct even if result is wrong. In this instance, students can get some points when they are evaluated. It is not important to use whether the use holistic scoring or analytic scoring in assessing, but important thing is that teachers should be more focus on the students' problem solving procedures not on directly result. Moreover, students should be evaluated with performance homework, activity sheets, projects, the exams which students can apply Polya's problem solving steps.

Other contribution of the steps to students is that for the students have difficulties in understanding the problems, those steps may be the ways to experience the success. Hence, teachers can follow the steps of the students and by this way; they guide to overcome the difficulties. To sum up, teacher should be aware of that each student can experience of solving a problem.

Apart from the steps and strategies, it is important that students learn by touching, by doing and living. In this study, it was observed that students were active in the lesson with mathematical activities especially presented visually. They were enjoying with doing or touching the concrete materials, so the result showed that those activities utilize learning as well as enjoying the mathematics. Thus, students should be active in lessons; that is learning should be student centered.

In order to put students in center of the learning, schools should also have sufficient materials such as sufficient computers for each student and other technological tools enhancing visual representation or demonstration for education in order to be used in mathematics lessons.

Finally, students in the present study were tried to explore themselves with their own words, for all students the suitable environment should be prepared to be self-exploration by the teachers.

5.5. Recommendations for Further Studies

The purpose of the study is to analyze the change of sixth grade students' mathematical problem solving ability after mathematics instruction based on Polya's problem solving steps. In addition, it is to investigate whether there will be a change in students' attitudes towards mathematics and mathematical problem solving after mathematics instruction based on Polya's problem solving steps.

The result of the study showed that reform based instruction had affects on problem solving skills as well attitudes towards problem solving and mathematics. The study was conducted to only one school. Therefore, the result of the study cannot be generalized to other schools. However, further studies can be carried out as covering more than one school. More studies should be conducted to investigate the effects of new curriculum reform on students' problem solving abilities.

In future studies there can be used a control group to see the changes strongly. Observers can also be assigned during the classroom activities. Moreover, the studies can be supported by the videos and during the problem solving process, ongoing assessment can be put into practice.

The sample of this study composed of 6^{th} grade students, but in further studies the sample could be selected from different grade levels since reform movement includes all grade levels.

Finally, in the further studies, the time can be allocated to whole year. In this way, the effectiveness of the Polya's problem solving steps can be observed and analyzed clearly.

REFERENCES

Akay, H. (2006). *The examination of the effect of mathematics instruction with problem posing approach on students' academic achievement, problem solving ability and creativity.* Unpublished Doctoral Dissertations. Gazi University, Ankara.

Akdemir, Ö. (2006). *İlköğretim Öğrencilerinin Matematik Dersine Yönelik Tutumları ve Başarı Güdüsü,* Yüksek Lisans Tezi, Dokuz Eylül Üniversitesi, İzmir.

Akınoğlu, O. & Ruhan, Ö. T (2007).The effect of problem-based active learning in science education on students' academic achievement, attitude and concept learning. *Eurasia Journal of Mathematics, Science & Technology Education,* 3(1), 71-81.

Alp, M. (2007). *Primary education 4th class the lesson of science and technology the examining and evaluating of the new school curriculum program*. Social Sciences Institute Unpublished Master Thesis of Educational Science, Konya.

Altun, M. (2000). İlköğretimde problem çözme öğretimi. *Millî Eğitim Dergisi* (147). *Retrieved* May 20, 2008, *from* http://yayim.meb.gov.tr/dergiler/147/altun.htm

Artique, M. & Houdement, C. (2007). Problem solving in France: Didactic and curricular perspectives. *ZDM Mathematics Education*, 39, 365-382.

Aşkar, P. (1986). Matematik dersine yönelik tutum ölçen likert tipi bir ölçeğin geliştirilmesi. *Eğitim ve Bilim* 62(11), 31-36.

Avşar, Z. & Alkış, Z. (2007). Effect of cooperative learning "Jigsaw I" technique on student success on social studies course. *Elementary Education Online, 6(2),* 197-203.

Aydın, S. (2007). *primary School 4th and 5th classes new (2004) social sciences content evaluation by sights of teachers (Trabzon city sample)*. Unpublished Master Thesis, Kafkas University, Kars.

Babadoğan, C., & Olkun, S. (2006). Program Development Models and Reform in Turkish Primary School Mathematics Curriculum. *International Journal for Mathematics Teaching and Learning. Retrieved from http://www.cimt.plymouth.ac.uk/journal /default.htm.*

Boero, P. & Dapueto, C. (2007). Problem solving in mathematics education in Itlay: Dreams and reality. *ZDM Mathematics Education*, 39, 383-393.

Bottge, A. Brain (2001). Reconceptializing mathematics problem solving for low-achieveing students. *Remedial and Spcial Education International Education Journal,* 22(2), 102-112, Hammill Institute Disabilities.

Brain, M. S. & Kren, J. M (1995). Portfolio driven reform: Verment teachers's understanding of mathematical problem solving and related cahnges in calssroom practice. Life contexts: An alternative for desing in technology education curriculum. *RAND Institute on Education and Training.* Los Angeles: University of California.

Bulut, M. (2007). Curriculum reform in Turkey: A case of primary school matematics curriculum. *Eurasia Journal of Mathematics, Science & Technology Education,* 3(3), 203-212.

Bulut, S. (1999). Cahnges in mathenmatics teachers education program in Turkey. *The Mathematics Educators*, 9(2), 30-33.

Burkhardt, H. & Bell, A. (2007). Problem solving in France: Problem solving in the United Kingdom. *ZDM Mathematics Education*, 39, 395-403.

Cai, J. & Nie, B. (2007). Problem Solving in France: Problem solving in Chinese mathematics education. Research and practice. *ZDM Mathematics Education*, 39, 459-473.

Çalışkan, S. (2007). Problem Çözme Strateji Öğretiminin Fizik Başarısı, Tutumu, Özyeterliği Üzerindeki Etkileri ve Strateji Kullanımı. Doktora Tezi, Dokuz Eylül Üniversitesi, İzmir.

Chamot, A. U., Dale M., O'Malley J. & Spanos G. A. (1992). Learning and problem solving strategies of ESL students. *Bilingual Research Journal,* 16, 1-34.

Charles, R., Lester, F., & O'Daffer, P. (1987). *How to Evaluate Progress in Problem Solving*, Reston, VA: National Council of Teachers of Mathematics.

Doorman, M., Drijvers, P., Dekker, T., Heuvel-Panhuizen, M., Lange, J. & Wijers, M. (2007). Problem solving as a challenge for mathematics education in the Netherlands: Dreams and reality. *ZDM Mathematics Education*, 39, 405-418.

Eden , H. (2006). *Ilköğretim Matematik 6 Mğretmen Kılavuzu Kitabı*. İstanbul: MERAM.

Eggen, P. & Kauchak, D, (2001). *Strategies for Teachers: Teaching Content and Thinking Skills*. Boston: Allyn and Bacon.

Fraenkel, J. R. & Wallen, N. E. (1996). *How to Design and Evaluate Research in Education*. New York: McGraw-Hill.

Garson, G. D. (2008). *Reliability analysis* retrieved from http://faculty.chass.ncsu.edu/garson/PA765/reliab.htm

Gök, T. (2006). *Fizik eğitiminde işbirlikli öğrenme gruplarında problem çözme Stratejilerinin, öğrenci başarısı, başarı güdüsü ve tutumu üzerindeki etkileri*, Unpublished Doctoral Dissertations, Dokuz Eylül Üniversitesi, İzmir.

Green, S. B., Salkind, N. J., & Akey, T. M. (2000). *Using SPSS for Windows: Analyzing and Understanding Data*. New York: Printice Hall.

Grossman, G. M., Onkol, P. E. & Sands, M. (2007). Curriculum refrom in Turkish Education: Attitudes of teacher educators towards change in an EU Candidate Nation. *International Journal of Educational Development,* 27, 138-150.

Hiebert, J. & et al. (1996). Problem solving as a basis for reform in the curriculum and instruction: The case of mathematics. *Educational Research*, 9(2), 12-21.

Hill, A. M. (1998) Problem Solving in Real-Life Contexts: An Alternative for Design in Technology Education. *International Journal of Technology and Design Education 8,* 203–220.

Hill, A. M. (2007). Problem solving in real life contexts: An alternative for desing in technology education curriculum. *Internationa Journal of Technology and Design Education,* 8, 204-220.

Hino, K. (2007). Toward the problem centered classroom: Trends in Mathematical Problem Solving in Japan. *ZDM Mathematics Education*, 39, 503-514.

International Committee of Museum Educators Conference (1991), *Constructivist Learning Theory*. Massachusetts, Lesley College.

Koç, Y. (1998). *The effects of different teaching methods on mathematical problem solving performance*. Master Thesis. Middle East Technical University, Ankara.

Lloyd, G. M. (1999). Two teachers' conceptions of a reform-oriented curriculum: Implications for mathematics teachers' development. *ZDM Mathematics Education*, 2, 227-252, USA: University of Montana.

Middleaton, A. J. & Spanias, P. A. (1999). Motivation for achievemnt in mathematics: Findings, generalizations and criticisms of the research. *Journal for Research in Mathematics Education*, 30(1), 65-88.

Miller, M. D. & Pajares F. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving: A path analysis. *Journal Of Self Educational Psychology*, 86(2), 193-203.

National Council of Teachers of Mathematics [NCTM] (2000). *Principles and Standards for School Mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics [NCTM] (2003). *Principles and Standards for School Mathematics*. Reston, VA: Author.

Olkun, S. & Uçar, Z. T. (2004). *İlköğretim Etkinlik Temelli Matematik Öğretimi*, Ankara: Anı.

Özsoy, G. (2005). Problem çözme ile matematik çözme başarısı arasındaki ilişki. *Gazi Eğitim Fakültesi Dergisi,* 25(3), 173-190.

Plourde, L. A. & Alawiye, O. (2003). Constructivism and elementary pre-service science teacher preparation: Knowledge to application. *College Student Journal*.

Polya, G. (1973). *How to solve it: A New Aspect of Mathematical Method*. N. J: Princeton University Press.

Popkewitz, T. (1999). Introduction: Critical traditions, modernisms, and the posts. In T. Popkewitz & L. Fendler (Eds.). Critical theories in education (pp. 1-17). New York, Routledge.

Posamentier, A. S. & Jaye, D. (2005). *What Successful Math Teachers Do, Grades 6-12: 79 Research-based Strategies for the Standards-based Classroom*. California: Corvin Press.

Programme for International Student Assessment [OECD] (2003). Retrived from www.oecd.org/bookshop.

Reiss, K. & Törner G. (2007). Problem solving in the mathematics classroom: The German perspective. *ZDM Mathematics Education*, 39, 431-441.

Sagor, R. (2000). *Guiding School Improvement with Action Research Reform*. ASCD Publishing.

Schoenfeld, A. H. (1992). *Learning to think mathematically, problem solving, metacognition and sense making in mathematics. In D. A Grouws (Ed.) handbook of research on mathematics: Teaching and Learning.* IAP Publisher.

Schoenfeld, A. H. (1994). *An Extensive Review of the Literature in the Area of Curriculum Reform in Science, Math. & Higher Order Thinking Across the Disciplines.* Diane Publishing.

Sert, N. (2008). Constructivism in the elementary school curricula. *Journal of Theory and Practice in Education*, 4(2), 291-316.

Sezendrei, J. (2007). When the goings get tough, the tough gets problem solving in Hungary, 1970-2007: Research and theory, practice and politics . *ZDM Mathematics Education*, 39, 443-458.

Silver, E. A. (1997). Fostering creativity though instruction rich in mathematical problem solving and problem posing. *International Reviews on Mathematical Education, 29,* 75-80.

Silver, E. A. (1985). *Teaching and learning mathematical problem solving: Multiple research Perspectives.* Lawrence Erlbaum Associates.

Sriraman, B. & Pizzulli, M. (2005). Balancing mathematics education research and NCTM Standards. *ZDM Mathematics Education*, USA: University of Montana, 37(5), 431-436.

Talim ve Terbiye Kurumu Başkanlığı [TTKB] (2007). *İlköğretim matematik dersi 6-8 sınıflar öğretim programı ve kılavuzu*: Ankara. MEB.

Tural, H. (2005). İlköğretim Matematik Öğretiminde Oyun ve Etkinliklerle Öğretimin Erişi ve Tutuma Etkisi. Yüksek Lisans Tezi, Dokuz Eylül Üniversitesi, İzmir.

Wilson, J. W., Fenandez, M.L., & Hadaway, N. (2007). Mathematical problem solving. *Retrieved from http://jwilson.coe.uga.edu/emt725/PSsyn/PSsyn.html*

Yavuz, G. (2006). *Dokuzuncu sınıf matematik dersinde problem çözme strateji öğretiminin duyuşsal özellikler ve erişiye etkisi,* Unpublished Doctoral Dissertations, Dokuz Eylül Üniversitesi, İzmir.

Yazgan, Y. & Bintaş, J. (2005). İlköğretim dördüncü ve beşinci sınıf öğrencilerinin problem çözme stratejilerini kullanabilme düzeyleri: Bir öğretim deneyi. *Hacettepe University Educatinal Journal*, 28, 210-218.

Yıldız, İ. & Uyanık, N. (2004). Matematik eğitimde ölçme değerlendirme üzerine. *Kastamonu Educational Journal,* 12(1), 97-104.

APPENDIX A

PROBLEM SOLVING TEST

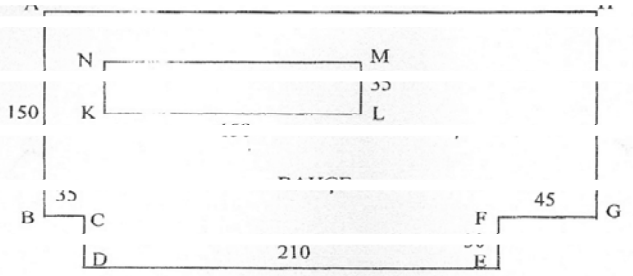
6 SINIFLAR PROBLEM ÇÖZME TESTİ

Bu test 6.Sınıflarda II-III-IV. Üniteleri kapsayan 21 soruluk bir değerlendirme testidir.

Aşağıdaki her soruyu dikkatli okuyunuz, çözümünü açık bir şekilde yapınız.

PROBLEMLER

1. Bir okul bahçesinin planı aşağıdaki gibidir. **Şekli kullanarak soruları yanıtlayınız. Çözümünü açık bir şekilde yazınız.**



[AB] = 150 m
[BC] = 30 m
[DE] = 210 m
[FG] = 45 m
[KL] = 150 m
[LM] = 30 m

a) Okul bahçesinin çevresi kaç metredir? **Çözümünü açık bir şekilde yazınız.**

b) Sadece okulun alanı ne kadardır? **Çözümünü açık bir şekilde yazınız.**

2.

Adet	Ürün	Birim Fiyatı
2 tane	Ekmek	35 Ykr
2 paket	Süt	150 Ykr
6 tane	Yumurta	15 Ykr
3 paket	Vanilya	25 Ykr

Burcu yukaridaki alış veriş listesinde fiyatları ve adetleri yazılı olanları alacak. Burcu alış verişe giderken yanına 4,5 YTL para almıştır. Bu para listedekileri almaya yeterli mi, değilse daha ne kadar gerekli? **Çözümünü açık bir şekilde yazınız.**

3.Aşağıdaki hikâyede bütün sayılar çıkartılmıştır. Verilen sayıları boşluklara uygun şekilde yerleştiriniz. Tüm sayıları birer defa kullanmanız gerekiyor.

Birkitapçının eline yeni "Keloglan" serisinden _____kitap gelmiştir. Kitapçı, sattığı bu kitapların her birinden_____ YTL kâr etmektedir. İlk gün kitapların_____ tanesini, ikinci gün kalan bütün kitapları satmıştır. İkinci gün sattığı kitaplardan_____ YTL kâr ettiğine göre, bu kitapçının toplam satıştan kaç YTL kâr ettiğini bulunuz.

540 4,5 300 100

Çözümünü açık bir şekilde yazınız.

2

4. Okuldan sonra size yarı zamanlı bir iş teklif edildi: Bilim ve Çocuk (fiyatı 3 YTL'dir.) dergilerini okulun çıkışında satmanız isteniyor. Size karşılığında 3 farklı ödeme şekli sunuluyor:

a) Aylık 250 YTL

b) Her gün 5 kişiye sattığını düşünürsek, aylık 150 YTL ve her dergi için 0,5 YTL kâr

c) Her gün 5 kişiye sattığını düşünürsek, aylık 50 YTL ve her dergi için 1 YTL kâr öneriliyor.

Size sunulan bu ödemelerden hangisini seçerdiniz? Nedenini açıklayınız.

5. Aşağıdaki geometri tahtasır a yer alan şeklin alanı kaç birim karedir?
Çözümünü açık bir şekilde y zınız.

3

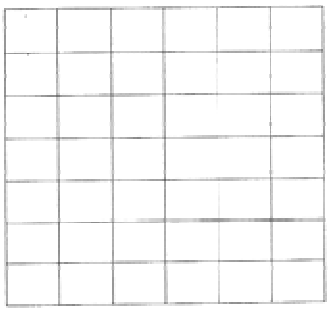
6. Cem, bayramda bir torba şeker topladı. Cem, önce topladığı şekerlerin yarısını kardeşi Ahmet ile paylaştı. Sonra elinde kalan şekerlerinin yarısını çok az şeker toplayabilen arkadaşı Duygu'ya verdi. Geriye 10 şekeri kalan Cem'in dağıtmadan önce kaç şeker topladığını bulunuz.

Çözümünü açık bir şekilde yazınız.

7. Selim, 20 soruluk çoktan seçmeli bir sınava girdi. Her doğru soru için 5 puan alınan, her yanlış soru için ise 2 puan kırılan bu sınavda Selim 48 puan aldı.

Bu nasıl oldu sizce? Böyle bir şey olabilir mi? Nedenini açıklayınız.

8. **İletki ve cetvel kullanarak** yandaki kareli alana dar bir açı çiziniz.
Açıyı sembol kullanarak gösteriniz ve açının ölçüsünü yazınız.



4

9. Mehmet resim-iş dersi için telden çerçeve yapacaktır. Dikdörtgen şeklindeki çerçeveyi uzun kenarı kısa kenarının iki katı olacak şekilde yapacaktır. Mehmet'in elinde 36 cm uzunluğunda tel olduğuna göre, bu çerçevenin uzun kenarı kaç cm olur?
Şekil çizerek çözümünü açık bir şekilde yazınız.

10.Öğretmenleriyle birlikte 500 öğrenci hafta sonu Belgrat Ormanı'na piknik yapmaya gidiyor. Otobüsler 1'den başlayarak numaralandırılıyor, öğrenciler sıraya göre 1. otobüsten başlayarak biniyorlar. Tuncay 249. sırada bekliyor. Buna göre, aşağıdaki soruları yanıtlayınız.

Bu yolculukta

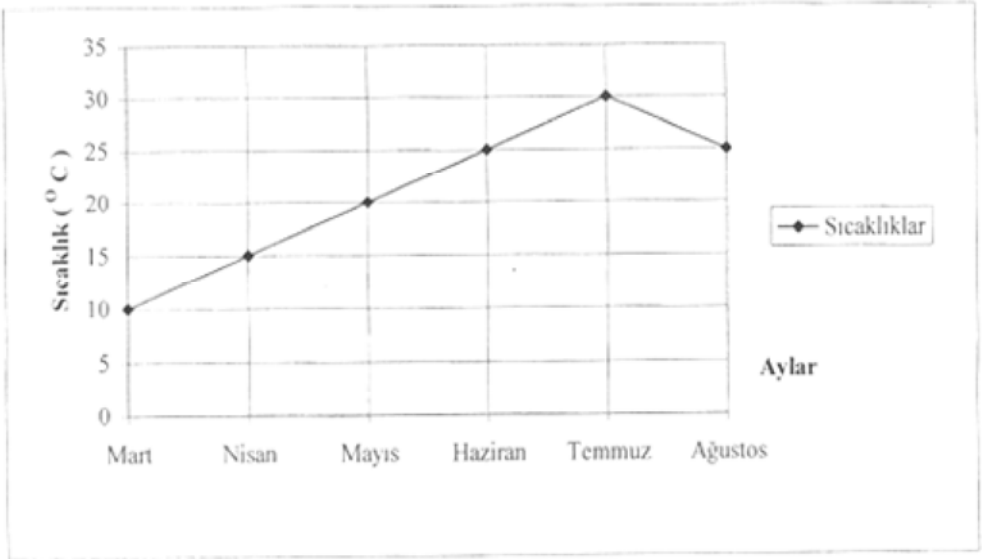
a) Bir otobüs kaç öğrenci alabilir, tahmin ediniz. Tahmin sonucunu yazınız ve nasıl tahmin ettiğinizi yazınız. **Çözümünü açık bir şekilde yazınız.**

b) Toplam kaç otobüs olduğunu tahmininize göre cevaplayınız. **Çözümünü açık bir şekilde yazınız.**

c) Tuncay, kaç numaralı otobüse binmiş olabilir? **Çözümünü açık bir şekilde yazınız.**

d) 70.sıradaki öğrenci kaç numaralı otobüse binmiş olabilir? **Çözümünü açık bir şekilde yazınız.**

11. İstanbul'un aylara göre ortalama sıcaklıklarını gösteren grafik aşağıda verilmiştir. Grafiği inceleyiniz, soruları yanıtlayınız.



a) Nisan ayında ortalama sıcaklık kaç derecedir? **Çözümünü açık bir şekilde yazınız.**

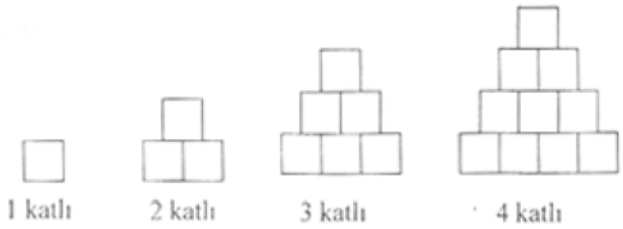
b) Bu aylar içinde ortalama en yüksek sıcaklıkla en düşük sıcaklığın farkı kaç derecedir? **Çözümünü açık bir şekilde yazınız.**

c) Hangi aylarda ortalama sıcaklık eşit olmuştur? **Çözümünü açık bir şekilde yazınız.**

d) Haziran ayı ile mart ayının ortalama sıcaklık farkı kaç derecedir? **Çözümünü açık bir şekilde yazınız.**

6

12. Bir fabrika aşağıdaki plana göre ofis binaları üretmek istemektedir. Beş katlı binada kaç tane ofis vardır? Yedi katlı binada kaç tane ofis vardır? Bunları bulurken nasıl bir yol izlersiniz? **Her bir kare bir ofisi gösterir.**



Her adımı açık bir şekilde yazınız.

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14. Ali, Burak ve Emel bir oyun oynamaktadırlar. Üç ayrı bölümden oluşan bu oyunda oyunun 1. bölümünde Ali 4 ve Burak 6 puan kazanır. İkinci bölümde Emel 3 puan kazanır, Burak ise 3 puan kaybeder. Üçüncü bölümde de Ali 2 puan kaybeder ve Burak 5 puan kazanır. Oyunu kim kazanmıştır?

Liste oluşturarak çözümünü açık bir şekilde yazınız.

---

14. Sevim, farklı renkte 5 kareyi kullanarak bir örüntü modeli oluşturacaktır. Kırmızı, mavi, yeşil, sarı, kahverengi renklerini kullanacaktır. Renklerin sırasını değiştirerek kaç farklı örüntü modeli oluşturulabilir?

Şekil çiziniz ve çözümünüzü açık bir şekilde yazınız:

---

15. Aşağıda verilen problemde eksik bilgi var mıdır? Varsa bulunuz, nedenini açıklayınız.

Adem, Cumhur ve Selin bir koşuda yarışmaktadır. Adem, Selin'in önünde, Cumhur da Selin'in önünde yarışı bitirmiştir. Yarışı kim kazanmıştır?

Çözümünü açık bir şekilde yazınız.

16. $(6^3)(5^4) = (N) \cdot (900)$ verilen işlemde N doğal sayısını nasıl bulursunuz?

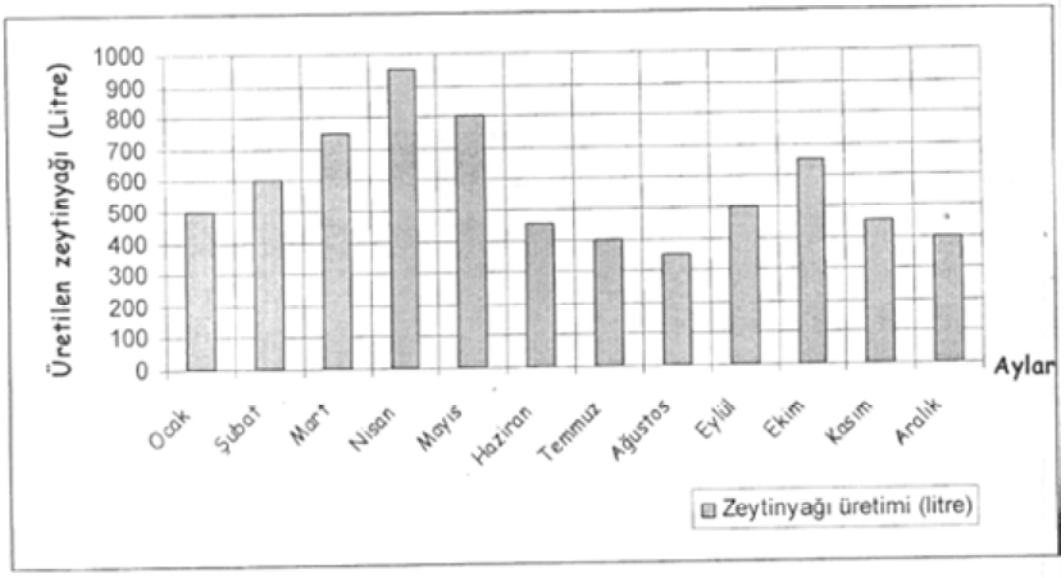
Çözümünü açık bir şekilde yazınız.

17. Aşağıda verilenlerle bir problem oluşturunuz. **Problemi çözmenize gerek yoktur.**

Bir taksi şöförü işe başlamadan önce arabasına 40 litre mazot koydurdu. Araba her 10 km kilometrede ortalama 0,5 litre mazot yakmaktadır. İlk müşterisini Sirkeci'den 28 km uzaklıkta olan Atatürk Havalimanı'na götürecektir.

Problem:

18. Bir fabrikanın zeytinyağı üretimi aşağıdaki grafikte verilmiştir. Bu bilgileri kullanarak bir problem yazınız.



Problem:

9

19. Aşağıda, verilen problemde fazladan bilgi var mıdır?Varsa bulunuz, nedenini açıklayınız.

Bir oyunda yer alan renkli taşların her bir renk farklı puanları gösterir. Mavi 2 puanı, kırmızı 5 puanı, sarı da 3 puanı gösterir. Bu oyunda, 15 tane sarı taşı olan Eda'nın 64 puanı vardır. Buna göre Eda'nın en fazla kaç tane kırmızı taşı vardır?

Fazla bilgi nedir? Nedenini açıklayınız.

20. 32 kişilik bir sınıfta her biri spor ya da sanat etkinliklerinden en az birine katılmaktadır. Sanat etkinliklerine katılan 24, her iki etkinliğe katılan 6 öğrenci olduğuna göre, yalnız spor etkinliğine katılan kaç öğrenci vardır?

Çözümünü açık bir şekilde yazınız.

21. Bir çiftlikte tavşan ve tavukların toplamı 32'dir. Bu çiftlikte 80 ayak olduğuna göre, kaç tavuk, kaç tavşan olduğunu bulunuz.

Çözümünü açık bir şekilde yazınız.

APPENDIX B

PROBLEM SOLVING ATTITUDE SCALE

PROBLEM ÇÖZMEYE YÖNELİK TUTUM ÖLÇEĞİ

İsim-Soyisim:.....

AÇIKLAMA: Aşağıda problem çözmeye ilişkin tutum cümleleri ile her cümlenin karşısında "Kesinlikle Katılıyorum", "Katılıyorum", "Kararsızım", "Katılmıyorum" ve "Hiç Katılmıyorum" olmak üzere beş seçenek verilmiştir. Her bir cümleyi dikkatli okuyarak, **boş bırakmadan** bu cümlelere ne ölçüde katıldığınızı seçeneklerden birini işaretleyerek belirtiniz. Bu cümlelerin **doğru ya da yanlış cevapları** bulunmamaktadır. Yalnızca sizin doğru bulduğunuz cevaplar doğru kabul edilmektedir. Mümkün olduğunca yaşadıklarınızı düşünerek karar veriniz. Bu anket yalnızca araştırma amacıyla kullanılacaktır ve verdiğiniz cevaplar **kesinlikle gizli tutulacaktır.** Yardımlarınız için çok teşekkür ederiz.

	Kesinlikle Katılıyorum	Katılıyorum	Kararsızım	Katılmıyorum	Hiç Katılmıyorum
1. Problem çözmek beni huzursuz eder.					
2. Problemleri, sadece cevap vermiş olmak için öylesine çözerim.					
3. Zor problemlerle uğraşmayı severim.					
4. Problem çözmeye çalışmak sıkıcıdır.					
5. Problem çözmek düşünme yeteneğimi geliştirir.					
6. Problem çözerken kafam karışmaz.					
7. Problemlerin çözümüyle ilgili fikirlerimin, diğer çocuklarınki kadar iyi olmamasından endişe duyarım.					
8.Bir cevap buluncaya kadar problemle uğraşmaktan hoşlanırım.					
9. Bir problem üzerinde uzun süre uğraşmak beni sıkmaz.					
10. Problem çözmeye çalışmaktan hoşlanırım.					
11. Matematik dersinde problem çözerken kazandığım beceriler bana diğer derslerimde yardımcı olmaz.					
12. Öğretmenim tahtada bir matematik problemini çözerken sıkıntı duyarım.					
13. Bir problemi çözüm yolunu öğrendikten sonra benzer problemleri çözebilirim.					
14. Bir problemin birden fazla çözümünü bulmaya çalışmak zihinsel gelişim açısından yararlıdır.					
15. Matematik problemlerini çözmek bana çekici gelmiyor.					
16. Zor matematik problemleri ile uğraştığımı düşündüğüm zaman, kendimi çaresiz hissederim.					

17. Matematik problemi çözerken öğrendiklerimin bana gerçek yaşamda yardımcı olacağına inanmıyorum.					
18. Bir problemin çözümünü sınıfta tartışmak zevkli bir iştir.					
19. Problem çözmeyi düşünmek bile sinirlerimi bozuyor.					
20. Çözmeyi denemeyeceğim bazı problemler vardır.					
21. Anlaşılması zor problemlerle bile uğraşırım.					
22. Problemlerin çoğunu çözebileceğime eminim.					
23. Bir problemin çözümünü veren denklemi bulabilirim.					
24. Bir problemi değişik yöntemlerle çözerim.					
25. Problem çözmek beni korkutmaz.					
26. Matematik derslerinde problem çözmeye daha çok zaman ayrılmasını isterim.					
27. Bir problemi tahtada çözmem istendiğinde endişelenmem.					
28. Gelecekteki çalışmalarımda problem çözme becerilerine ihtiyaç duyacağım.					
29. İyi problem çözebilen birisiyim.					
30. Çoğu problemi çözmek eğlenceli bir iştir.					
31. Problem çözmek matematiğin en zevkli alanıdır					
32. Matematik problemi çözmenin ilerideki mesleğimde yararlı olacağını düşünmüyorum.					
33. Çoğu zor problemi çözebilirim.					
34. Problem çözme konusunda herkesten daha iyiyim.					
35. Bir problemi nasıl çözdüğümü açıklamam istendiğinde, bundan endişe duymam.					
36. Problem çözerken başarısız olacağımı düşünürüm.					
37. Matematik dersinde problem çözerken kazandığım beceriler bana diğer derslerimde yardımcı olmaz.					
38. Problemleri çözmek için değişik yöntemler düşünürüm.					
39. Problem çözerken zorlanınca hemen vazgeçerim.					

APPENDIX C

MATHEMATICAL ATTITUDE SCALE

Adınız Soyadınız:…….. Cinsiyetiniz:……..

Okulunuzun İsmi:……. Sınıfınız:……

	Tamamen Uygundur	Uygundur	Kararsızım	Uygun Değildir	Hiç Uygun Değildir
1. Matematik sevdiğim bir derstir.	O	O	O	O	O
2. Matematik dersine girerken büyük sıkıntı duyarım.	O	O	O	O	O
3. Matematik dersi olmasa öğrencilik hayatı daha zevkli olur.	O	O	O	O	O
4. Arkadaşlarımla matematik tartışmaktan zevk alırım.	O	O	O	O	O
5. Matematiğe ayrılan ders saatlerinin fazla olmasını dilerim.	O	O	O	O	O
6. Matematik dersi çalışırken canım sıkılır.	O	O	O	O	O
7. Matematik dersi benim için angaryadır.	O	O	O	O	O
8. Matematikten hoşlanırım.	O	O	O	O	O
9. Matematik dersinde zaman geçmez.	O	O	O	O	O
10. Matematik dersi sınavından çekinirim.	O	O	O	O	O
11. Matematik benim için ilgi çekicidir.	O	O	O	O	O
12. Matematik bütün dersler içinde en korktuğum derstir.	O	O	O	O	O
13. Yıllarca matematik okusam bıkmam.	O	O	O	O	O
14. Diğer derslere göre matematiği daha çok severek çalışırım.	O	O	O	O	O
15. Matematik beni huzursuz eder.	O	O	O	O	O
16. Matematik beni ürkütür.	O	O	O	O	O
17. Matematik dersi eğlenceli bir derstir.	O	O	O	O	O
18. Matematik dersinde neşe duyarım.	O	O	O	O	O
19. Derslerin içinde en sevimsizi matematiktir.	O	O	O	O	O
20. Çalışma zamanımın çoğunu matematiğe ayırmak isterim.	O	O	O	O	O

APPENDIX D

THE PLAN OF UNIT ONE

6. SINIF MATEMATİK DERSİ ÜNİTELENDİRİLMİŞ YILLIK PLAN

AYLAR	ÜNİTE NU.	ÖĞRENME ALANI	ALT ÖĞRENME ALANI	KAZANIMLAR	Süre/ Ders Saati	AÇIKLAMALAR	Ders İçi İlişkilendirme	Diğer Derslerle İlişkilendirme / Ara Disiplinlerle İlişkilendirme	DEĞERLENDİRME
	I	SAYILAR	Doğal Sayılar	1. Doğal sayılarla işlemler yapmayı gerektiren problemleri çözer ve kurar.	2	İşlemlerde gerektiğinde hesap makinesi kullandırılabilir. Bazı hesap makinelerinin işlem sırasının olduğu, bazılarında ise olmadığı, bu nedenle işlem sonuçlarının farklı çıkabileceği belirtilir. Birden fazla işlem olduğu durumlarda hangi işlemin daha önce yapılacağı ayraçlarla belirtilir. İşlem sıraları ayraçlarla belirlenmemişse işlemlerde önce parantez içindeki işlemler, sonra çarpma veya bölme işlemleri, daha sonra da toplama veya çıkarma işlemleri yaptırılır. Aynı önceliklere sahip işlemlerde soldan sağa doğru sıra takip edilir.		• Kariyer Bilincini Geliştirme (Kazanım 13, 14)	• Performans ödevi ile değerlendirme • "Form 5", "Form 7", "Form 8", "Form 6" ve "Form 13", kullanılarak değerlendirme
		GEOMETRİ	Doğru, Doğru Parçası ve Işın	1. Doğru ile nokta arasındaki ilişkiyi açıklar.	8	Doğrular, üzerlerindeki herhangi iki nokta ile isimlendirilip sembolle gösterilir: K L doğrusu "KL" veya "KL" biçiminde gösterilir. Doğruların küçük harflerle de isimlendirilip d, f, k vb. ile gösterildiği hatırlatılır. Doğru üzerinde alınan noktaların "•" işareti konularak belirlenmesine dikkat edilir. Aynı bir doğru üzerinde bulunan noktalara doğrudaş noktalar denir. Kâğıt katlama yönteminde nokta modelinin (kavşak noktasından hareketle) kesişen iki kat çizgisi ile belirlenebileceği vurgulanır. Katlama etkinliklerinde şeffaf veya yağlı kâğıt kullanılır.			• "Form 2" ve "Form 13 kullanılarak değerlendirme

AYLAR	ÜNİTE NU.	ÖĞRENME ALANI	ALT ÖĞRENME ALANI	KAZANIMLAR	Süre / Ders Saati	AÇIKLAMALAR	Ders İçi İlişkilendirme	Diğer Derslerle İlişkilendirme / Ara Disiplinlerle İlişkilendirme	DEĞERLENDİRME
	I	GEOMETRİ	Doğru, Doğru Parçası ve Işın	**2.** Doğru parçası ile ışını açıklar ve sembolle gösterir.		⚠ Doğru parçasını, uç noktalarını, ışını, ucu ile üzerindeki herhangi bir noktayı kullanarak isimlendirmenin ve sembolle göstermenin iki farklı yolundan biri ile yapıldığı vurgulanır. Üzerinde bulundukları doğrunun gösterim biçimine göre kullanılan notasyon sistemleri aşağıda gösterilmiştir.			

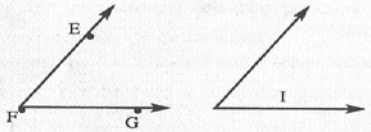
Şekil adı	Çizgi ile gösterim	Sembolle gösterim	
Doğru	$\overleftrightarrow{AB}$	$\overleftrightarrow{AB}$	AB
Doğru parçası	$\overline{CD}$	$\overline{CD}$	[CD]
Işın	$\overrightarrow{EF}$	$\overrightarrow{EF}$	[EF
Doğru parçasının uzunluğu		|CD|	

Kullanım için bu sistemlerden biri seçilir; fakat diğer sistemden de söz edilir.

⚠ Işın ve doğru parçası üzerinde alınan noktaların "•" işareti konularak belirlenmesine dikkat edilir.

				3. Bir doğru parçasına eş bir doğru parçası inşa eder.		⚠ Uzunlukları eşit olan doğru parçalarının eş oldukları vurgulanır. ⚠ "Eşlik" ve "eşitlik" kavramlarının farklı olduğu hatırlatılır. Bu fark, eş şekillerin, ölçüleri eşit ve biçimleri benzer-aynı şekillerden kaynaklandığından eşlik, eşitlik ve benzerlik sembollerinin birleşimi olan " ≅ " sembolü ile temsil edilir. ⚠ Ölçülü çizimlerde cetvel ile ölçüleri olan pergel veya gönye kullanılır. Ölçüsüz çizimlerde ise bir kenarı düz olan materyal (çizgilik, çizgeç), ölçüleri olmayan pergel veya gönye kullanılır.			

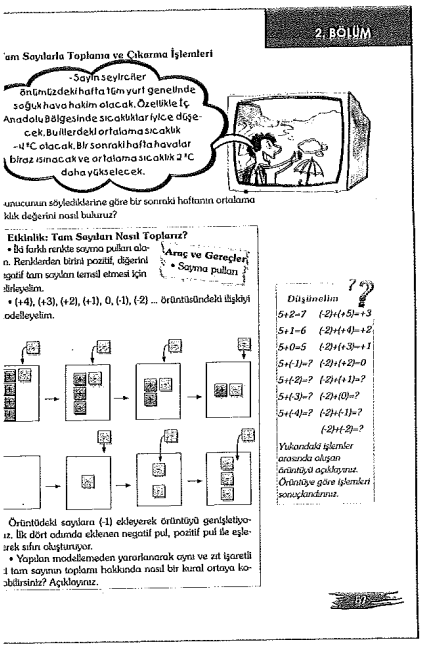
AYLAR	ÜNİTE NU.	ÖĞRENME ALANI	ALT ÖĞRENME ALANI	KAZANIMLAR	Süre / Ders Saati	AÇIKLAMALAR	Ders İçi İlişkilendirme	Diğer Derslerle İlişkilendirme / Ara Disiplinlerle İlişkilendirme	DEĞERLENDİRME
	I	GEOMETRİ	Doğru, Doğru Parçası ve Işın	**4.** Aynı düzlemdeki iki doğrunun birbirlerine göre durumlarını belirler ve sembolle gösterir.		⚠ Aynı düzlemde kesişmeyen doğruların paralel doğrular olduğu vurgulanır. ⚠ Dikliğin, kesişmenin özel bir durumu olduğu belirtilir. ⚠ $\overleftrightarrow{AB}$ ve $\overleftrightarrow{CD}$ doğruları paralel veya dik ise bu sırasıyla $\overleftrightarrow{AB} \parallel \overleftrightarrow{CD}$ ve $\overleftrightarrow{AB} \perp \overleftrightarrow{CD}$ biçiminde yazılır. Burada "$\parallel$" sembolünün paralelliği, "$\perp$" sembolünün ise dikliği temsil ettiği vurgulanır.			
				5. Bir doğrunun üzerindeki bir noktadan bu doğruya dikme çıkar ve dışındaki bir noktadan bu doğruya dikme inşa eder.		⚠ Bir noktanın bir doğruya olan uzaklığı, bu nokta ile bu noktadan doğruya inilen dikmenin ayağı arasındaki uzaklıktır. Başka bir deyişle, bu nokta ile dikme ayağını birleştiren doğru parçasının uzunluğudur. ⚠ Dışındaki bir noktayı, bir doğrunun noktalarına birleştiren doğru parçalarından en kısa olanı bu noktadan doğruya inilen dikmedir.			

AYLAR	ÜNİTE NU.	ÖĞRENME ALANI	ALT ÖĞRENME ALANI	KAZANIMLAR	Süre / Ders Saati	AÇIKLAMALAR	Ders İçi İlişkilendirme	Diğer Derslerle İlişkilendirme / Ara Disiplinlerle İlişkilendirme	DEĞERLENDİRME
	I	GEOMETRİ	Doğru, Doğru Parçası ve Işın	6. Bir doğru parçasının orta dikmesini inşa eder.		⚠ Orta dikmenin üzerindeki noktaların, doğru parçasının uçlarına olan uzaklıklarının eşit olduğu vurgulanır.			
				7. Bir doğruya dışındaki bir noktadan paralel inşa eder.		⚠ Paralel iki doğrudan birinin üzerindeki her bir noktanın, diğerine olan uzaklıklarının eşit olduğu vurgulanır. Bu yüzden paralel doğrulara, "eş uzaklıklı doğrular" denildiği belirtilir.			
				8. Uzayda bir doğru ile bir düzlemin ilişkisini belirler.		⚠ Dikliğin, kesişmenin özel bir durumu olduğu belirtilir.			
			Açılar	1. Açının düzlemde ayırdığı bölgeleri belirler.	2	⚠ Ortak uçlu iki ışının oluşturduğu şeklin açı olduğu ve bu ortak uca, açının köşesi denildiği vurgulanır. ⚠ Açı, ışın olan kenarları üzerindeki birer noktayla ve köşe (ortak uç olan) araya gelecek şekilde isimlendirilip sembolle gösterilir.  Şekilde açı "EFG açısı", "GFE açısı", "F açısı" veya "I açısı" olarak isimlendirilip; "EFG", "GFE", "LGFE". "F", "I" veya "<I" sembollerinden biri ile temsil edilir.			• "Form 2" ve "Form 3 kullanılarak değerlendirme

AYLAR	ÜNİTE NU.	ÖĞRENME ALANI	ALT ÖĞRENME ALANI	KAZANIMLAR	Süre / Ders Saati	AÇIKLAMALAR	Ders İçi İlişkilendirme	Diğer Derslerle İlişkilendirme / Ara Disiplinlerle İlişkilendirme	DEĞERLENDİRME
	I	GEOMETRİ	Açılar	2. Bir açıya eş bir açı inşa eder ve bir açıyı iki eş açıya ayırır.		⚠ Açı çizilirken kenarlarının uzun veya kısa çizilmesinin açının ölçüsünü değiştirmediği vurgulanır. ⚠ Dar, dik, geniş ve doğru açılar hatırlatılır. ⚠ Açıya ölçü karşılık tutulduğunda, okuma yönünün önemli olduğu vurgulanır. ⚠ Açı üzerindeki noktaların, bu açının iç veya dış bölgesine ait olmadıkları vurgulanır. ⚠ Açının köşesi ve açı üzerinde alınan noktalar "•" ile belirgin duruma getirilmelidir. ⚠ Bir açının açıortayının, ucu bu açının köşesi olan ve bu açının iç bölgesinde bulunan ışın olduğu vurgulanır.		⟲ • Fen ve Teknoloji dersi, Işık ve Ses ünitesi (Kazanım 1.5)	
			Çokgenler	1. Çokgenleri çizer ve inşa eder.	3	⚠ Dinamik geometri yazılımları kullanılarak çokgenler inşa ettirilebilir. ⚠ Çokgenin köşeleri "•" ile belirgin duruma getirilir. ⚠ Her tip çokgenin sahip olduğu ortak özellikler (köşe, açı, kenar sayısı vb.) incelenir. İnşalarda bunlar dikkate alınır. ⚠ Bir çokgenin dış bölgesinin, üzerinde bulunduğu düzlemin çokgenin kendisi ile iç bölgesi dışında kalan bölge olduğu vurgulanır.		⟲ • Türkçe dersi, Okuma Öğrenme Alanı, Görsel İletileri Algılama (Kazanım 3)	🗐 • "Form 10", "Form 11", "Form 2", "Form 12" ve "Form 13" kullanılarak değerlendirme

APPENDIX E

THE LESSON PLANS OF THE INTEGERS



2. BÖLÜM

'am Sayılarla Toplama ve Çıkarma İşlemleri

- Sayın seyirciler önümüzdeki hafta tüm yurt genelinde soğuk hava hakim olacak. Özellikle İç Anadolu Bölgesinde sıcaklıklar iyice düşecek. Bu illerdeki ortalama sıcaklık -4 °C olacak. Bir sonraki hafta havalar biraz ısınacak ve ortalama sıcaklık 2 °C daha yükselecek.

unucunun söylediklerine göre bir sonraki haftanın ortalama klık değerini nasıl buluruz?

Etkinlik: Tam Sayıları Nasıl Toplarız?

• İki farklı renkte sayma pulları alın. Renklerden birini pozitif, diğerini egatif tam sayıları temsil etmesi için irleşelim.

• (+4), (+3), (+2), (+1), 0, (-1), (-2) ... örüntüsündeki ilişkiyi odelleyelim.

Araç ve Gereçler
• Sayma pulları

Düşünelim

5+2=7 (-2)+(+5)=+3
5+1=6 (-2)+(+4)=+2
5+0=5 (-2)+(+3)=+1
5+(-1)=? (-2)+(+2)=0
5+(-2)=? (-2)+(+1)=?
5+(-3)=? (-2)+(0)=?
5+(-4)=? (-2)+(-1)=?
(-2)+(-2)=?

Yukarıdaki işlemler arasında alışan örüntüyü açıklayınız. Örüntüye göre işlemleri sonuçlandırınız.

Örüntüdeki sayılara (-1) ekleyerek örüntüyü genişletiyoız. İlk dört adımda eklenen negatif pul, pozitif pul ile eşlerek sıfır oluşturuyor.

• Yapılan modellemeden yararlanarak oyını ve zıt işaretli 1 tam sayının toplamı hakkında nasıl bir kural ortaya kobilirsiniz? Açıklayınız.

78

Notlar: _____

Tam Sayılarla Toplama ve Çıkarma İşlemleri

Süre: 4 ders saati
Beceriler: Problem çözme, akıl yürütme, ilişkilendirme, iletişim.
Kazanımlar: Tam Sayılarla İşlemler
1. Tam sayılarla toplama ve çıkarma işlemlerini yapar.
Doğal Sayılar
1. Doğal sayılarla işlemler yapmayı gerektiren problemleri çözer ve kurar.
Yöntem ve Teknikler: Sorgulama ve keşfetme, yaparak ve yaşayarak öğrenme.

Isındırma

• Ders kitabında yer alan resimdeki spikerin söyledikleri hakkında kısa bir tartışma ortamı oluşturulur.

• Spikerin verdiği bilgilere göre bir sonraki hafta ortalama sıcaklığın kaç derece olabileceği hakkında düşüncelerini söylemeleri ve nasıl bulduklarını açıklamaları yönünde öğrenciler cesaretlendirilirler.

• Bu şekilde öğrencilerin dikkatleri tam sayılarla toplama ve çıkarma işlemlerine çekilir.

• Öğrenciler öğrenmeye hazır hâle geldiğinde ders kitabındaki etkinliğe geçilir.

Merkezî Eğilim ve Yayılma Ölçüleri
(Ders kitabındaki resim)

Kazandırma

• Ders kitabındaki "Tam Sayıları Nasıl Toplarız?" etkinliğinin amacı, öğrencilerin tam sayılarla toplama ve çıkarma işlemlerini somut materyalleri kullanarak anlamlı bir şekilde zihinlerinde yapılandırabilmelerini sağlamaktır.

• Sayma pullarının olmadığı durumlarda etkinlik farklı renklerdeki oyun taşları (tavla pulları, renkli düğmeler gibi) ya da fasulye, nohut gibi malzemeler ile uygulanabilir.

• Etkinlikte modellenen örüntüde yer alan sayılar arasındaki değişim incelenerek tam sayılarla toplama işlemi kazandırılır.

• Etkinliğin sonunda basit toplama ve çıkarma işlemlerini yapmaları istenerek etkinliğin amacına ulaşıp ulaşmadığı kontrol edilir.

• Sayma pullarının kullanımıyla ilgili sağlık önlemleri alınır.

• Etkinlik sürecinde zaman ve malzeme tasarrufuna dikkat edilir.

• "Düşünelim" köşesinde verilen işlemler arasındaki örüntüler inceletilir.

• Etkinlikten sonra gerekli görülürse öğretmen kitabında verilen tamamlayıcı etkinlik uygulanabilir.

Tamamlayıcı Etkinlik: Toplayalım-Çıkaralım

Araç ve Gereçler: tebeşir, kalem, kâğıt, çengelli iğne

• Yere büyük bir sayı doğrusu çizilir.

• İki kâğıttan birine +, diğerine – işareti yazılır. Bu işaretler toplama veya çıkarma işlemi yapılacağını göstermek içindir.

• Toplama işlemi yapacak öğrenci + işaretli kâğıdı yakasına iğneler. (+3)+(+2), (+5)+(-3), (-2)+(+3), (-3)+(-4) toplama işlemleri ders kitabındaki örneklerde kullanılan arabanın hareket şekilleri kullanılarak dramatize edilir.

• Benzer şekilde – işaretli kâğıt öğrencinin yakasına iğnelenerek (+5)-(+3), (+4)-(+2), (+3)-(-1), (-2)-(-3) işlemleri yapılır.

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• Aşağıdaki işlemler farklı gruplardan öğrenciler tarafından önceki adımlar kullanılarak yapılır.

(-3)+(+5) ve (+5)+(-3)
(-2)+(-4) ve (-4)+(-2)
((-3)+(+2))+(-1) ve (-3)+((+2)+(-1))
(+3)+(-3) ve (-5)+(+5)

• Bu toplama işlemleri yapılarak tam sayılarla toplama işleminin değişme, birleşme ve ters eleman özellikleri incelenir.

• Ders kitabındaki örnekler inceletilir.

a-b ve a+(-b) işlemlerini gerektiren problemler, ayrı ayrı incelenir. Elde edilen çözümler karşılaştırılarak a-b=a+(-b) olduğu fark ettirilir.

Toplama işleminin değişme ve birleşme özellikleri incelenir.

Toplamları 0(sıfır) olan iki ayrı tam sayının toplama işlemine göre birbirinin tersi olduğu vurgulanır.

• Ders kitabındaki "Toplama ve Çıkarma İşlemlerinin Bazı Özellikleri" etkinliğinin amacı, tam sayılarla toplama ve çıkarma işlemlerinin özelliklerini fark ettirmektir. Fark etmeleri gereken özellikler toplama işleminin değişme ve birleşme özellikleri, bir sayının toplamaya göre tersi vb. özellikleridir.

• Tam sayılarla çıkarma işleminin değişme ve birleşme özelliklerinin olmadığı fark ettirilir.

• Gerekli görülürse öğretmen kitabında yer alan geliştirici etkinlik uygulanabilir.

• Sayma pulları ile ilgili sağlık önlemleri alınır.

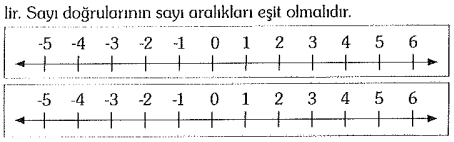
• Etkinlik sürecinde zaman ve malzeme tasarrufuna dikkat edilir.

Geliştirici Etkinlik: Sürgülü Sayı Cetveli Oluşturalım

Araç ve Gereçler: kalem, karton, makas, cetvel

• Kâğıt veya kartondan iki eş şerit kesilir.

• Şeritlerin uzun kenarında 1 cm geride sayı doğruları çizilir. Sayı doğrularının sayı aralıkları eşit olmalıdır.



• İşlemlere başlarken iki şeritteki "0"lar aynı hizaya getirilir.

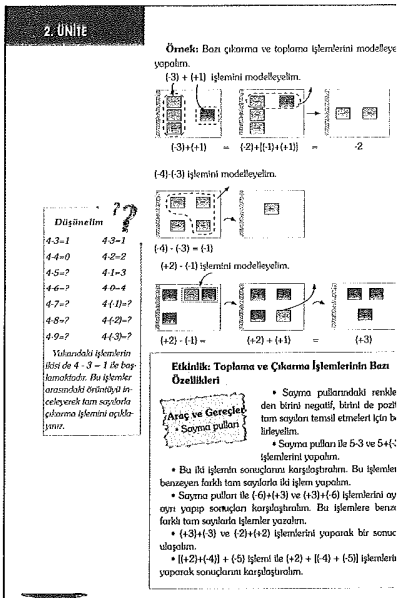
• (+5)+(-3) işlemi yapılırken alt şerit sabit tutularak üstteki şeridin "0" noktası önce 5 birim sağa sonra 3 birim sola kaydırılır. Sonuçta üstteki şeridin "0" noktasının alttaki şeritte aynı hizada olduğu sayı bulunur. Bu sayı işlemin sonucudur.

• (+3)-(+2) işleminde önce üst şerit 3 birim sağa kaydırılır. Sonra çıkarma işlemi olduğu için üst şerit yerinde kalarak, alt şerit (+2) birim sağa kayar. Üst şeritteki "0"ın alt şeritte gösterdiği sayı çıkarma işleminin sonucudur.

• (+3)-(-2) çıkarma işlemi yapılmış olsaydı çıkan negatif sayı olduğundan üst şerit 3 birim sağa kaydıktan sonra, alt şerit 2 birim sola kayacaktır.

• (+5)+(+4), (+6)+(-3), (-7)+(+4), (-8)+(-5), (-4)+(+4), (-3)+(-3) toplama işlemleri sırayla sayı cetveliyle yapılır.

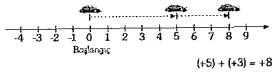
• (+5)-(+3), (+4)-(-2), (-3)-(+5),(-1)-(-4), (-2)-(-2), (-3)-(-3) işlemleri aynı şekilde yapılır.



Notlar: _____

Örnekler: Tam sayılarla yapılan bazı toplama ve çıkarma işlemlerini bir arabayı ileri, geri ve ters yönde ilerleterek modelleyelim. Sayı doğrusu üzerinde birlikte inceleyelim:

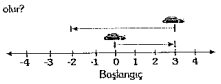
1. Araba 5 birim ilerliyor. Daha sonra aynı yöne 3 birim daha giderse en son konumu ne olur?



(+5) + (+3) = +8

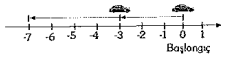
Arabanın hareketleri
(+): → İleri
(-): ← Geri
Çıkarma işlemi yapılacağı zaman araba yön değiştiriyor.

2. Araba 3 birim ileri, 5 birim geri gelirse en son konumu kaç olur?



(+3) + (-5) = -2

3. Araba 3 birim geri gidiyor, 4 birim daha geri giderse en son konumu ne olur?



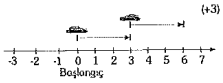
(-3) + (-4) = -7

4. 5 birim ilerleyen bir araç yönünü değiştirip 3 birim ilerlerse en son konumu ne olur?

(+5) - (+3) = +2

5. İleri doğru 3 birim giden araba, yön değiştirip 3 birim geri dönerse en son konumu ne olur?

(+3) - (-3) = (+6)



Notlar:

• Ders kitabındaki örneklerde tam sayılarla toplama ve çıkarma işlemleri modellenmiştir. Bu modeller ayrı ayrı incelenip matematiksel işlem olarak ifade ettirilir. Bu sayede tam sayılarla toplama ve çıkarma işlemlerinin daha anlamlı şekilde öğrencilerin zihinlerinde oluşması sağlanır.

• Örnek incelenirken arabaların yönlerine, ilk ve son konumlarına dikkat etmeleri istenir.

• Örnekler iyice yorumlandıktan sonra ders kitabındaki alıştırmalar sınıf ortamında bireysel olarak uygulatılır.

• Aşağıdaki ek alıştırmalar tam sayılarla toplama ve çıkarma işlemleri işlendikten sonra kullanılabilir.

Ek Alıştırmalar

•Aşağıdaki ifadeler doğru olacak şekilde boşlukları doldurunuz.

1. -12 > -15

2. 0 < 4

3. |-5| > -5

4. |-10| < 14

• Aşağıdaki tam sayılar arasında olan birer sayı yazınız.

5. -4, +2 (0)

6. 0, -4 (-2)

7. 5, 1 (4)

8. -8, -12 (-10)

• Aşağıdaki işlemleri yapınız.

9. -10+8 = (-2)

10. 7+(-9)=(-2)

11. (-3)+(-6)+4+(-4)=(-9)

12. (-1)+(-6)+12+(-8)=(-3)

13. (-20)+(-40)+112=(52)

14. 43-(-18)=(61)

15. (-10)-(-7)=(-3)

16. (-14)-(-14)=(0)

17. 0-47=(-47)

18. (-80)-(-41)=(-39)

19. (-90)-(-80)-19=(-29)

20. (+19)+(-24)+(-40)=(-45)

• Aşağıdaki sihirli karelerde her satır, sütun ve köşegen üzerindeki sayıların toplamları eşittir. Buna göre karelerdeki eksik sayıları bulunuz.

21.

-7	7	-3
3	-1	-5
1	-9	5

22.

-6	-7	-2
-1	-5	-9
-8	-3	-4

Uygulama

• Ders kitabındaki alıştırmaları bireysel olarak yapmaları sağlanır.

Ders kitabındaki alıştırmaların cevapları:

1. (+12) - (+4)=+8

2. (+15) - (-8)=+23

3. (-16) - (-14)=-2

4. (+15) + (+19)=+34

5. (-24) + (+5)=-19

6. (+36) + (-8)=+28

7. (-22) + (-14)=-36

8. (-4) + (+4) = (+4) + (-4) = 0

9. 16 - 8 = 16 + (-8) = +8

10. (-8) + (-4) = (-4) + (-8) = - 12

11. (-6) + (-11) = (-11) + (-6) = - 17

8, 9, 10 ve 11. sorularda sonuçların eşit çıkması tam sayılarla toplama işleminin değişme özelliği olduğunun göstergesidir.

12. [(-16) + (-5)] + (+36) = (-16) + [(-5)+(+36)] = +15

13. (+42) + [(-21)+(+13)]=[(+42)+(-21)]+(+13)=+34

12 ve 13. sorularda sonuçların eşit çıkması tam sayılarla toplama işleminin birleşme özelliği olduğunun göstergesidir.

14. +1 **15.** -16 **16.** -8 **17.** +5

• Daha fazla uygulama için öğrenciler çalışma kitabının 42. sayfasında yer alan "Tam Sayılarla Toplama ve Çıkarma İşlemleri" başlığı altındaki tüm soruları kitap üzerinde yapmaları için yönlendirilir.

Değerlendirme

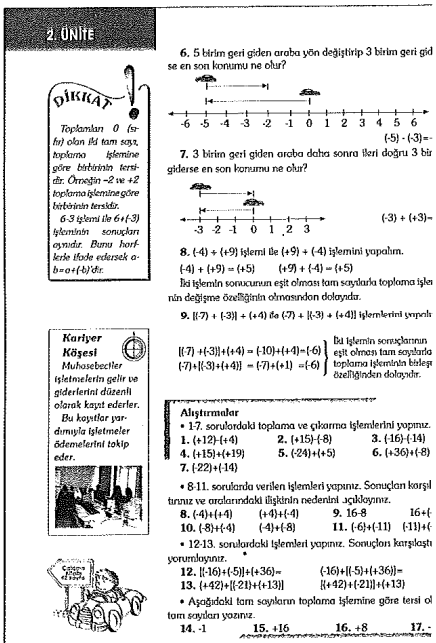
• Bu aşamada öğrenciler tam sayılarla toplama ve çıkarma işlemlerini yapabiliyor olmalılar. Ayrıca toplama işleminin değişme ve birleşme özellikleri ile bir sayının toplama işlemine göre tersinin öğrenilmiş olması gerekir.

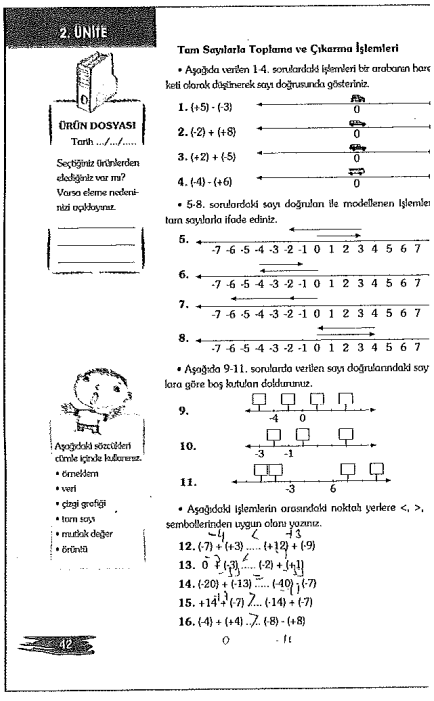
• Ders kitabındaki veya öğretmen kitabındaki etkinlikler uygulanarak öğrencilerin toplama ve çıkarma işlemlerini modellemeleri sağlanmalıdır. Modellemeler sonucunda işlemler hakkında genel kurallara ulaşıp ulaşmadıkları kontrol edilmelidir.

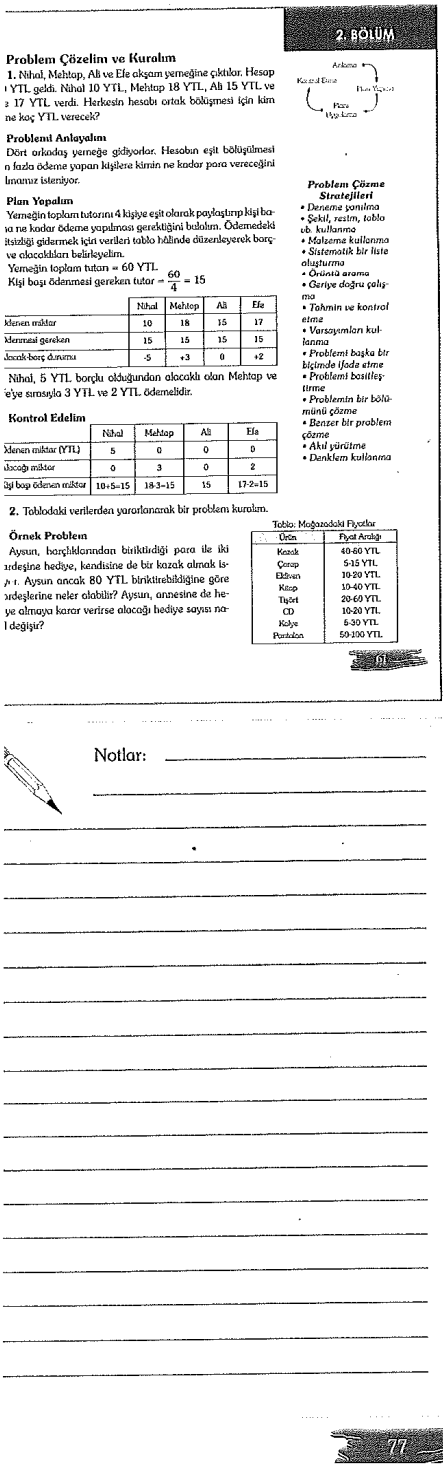
• Çalışma kitabındaki "Matematik Günlüğüm" köşesine öğrencilerin yazdıkları incelenerek işlenen konulara karşı öğrencilerin tutumları değerlendirilir.

• Öğretmen kitabının eklerinde yer alan ürün dosyası oluşturma ile ilgili örnek çalışma takvimindeki açıklamalar dikkate alınarak öğrencilerin çalışma kitabının 42. sayfasındaki "Ürün Dosyası" köşesini doldurmaları sağlanır.

Notlar: _____







2. BÖLÜM

Problem Çözelim ve Kuralım

1. Nihal, Mehtap, Ali ve Efe akşam yemeğine çıktılar. Hesap ı YTL geldi. Nihal 10 YTL, Mehtap 18 YTL, Ali 15 YTL ve 17 YTL verdi. Herkesin hesabı ortak bölüşmesi için kim ne kaç YTL verecek?

Problemi Anlayalım

Dört arkadaş yemeğe gidiyorlar. Hesabın eşit bölüştülmesi n fazla ödeme yapan kişilere kimin ne kadar para vereceğini lmamız isteniyor.

Plan Yapalım

Yemeğin toplam tutarını 4 kişiye eşit olarak paylaştırıp kişi başı ıa ne kadar ödeme yapılması gerektiğini bulalım. Ödemedeki itsizliği gidermek için verileri tablo hâlinde düzenleyerek borç- ve alacakları belirleyelim.

Yemeğin toplam tutarı = 60 YTL.

Kişi başı ödenmesi gereken tutar = $\frac{60}{4} = 15$

	Nihal	Mehtap	Ali	Efe
ödenen miktar	10	18	15	17
ödenmesi gereken	15	15	15	15
alacak-borç durumu	-5	+3	0	+2

Nihal, 5 YTL borçlu olduğundan alacaklı olan Mehtap ve 'e'ye sırasıyla 3 YTL ve 2 YTL ödemelidir.

Kontrol Edelim

	Nihal	Mehtap	Ali	Efe
ödenen miktar (YTL)	5	0	0	0
alacağı miktar	0	3	0	2
kişi başı ödenen miktar	10+5=15	18-3=15	15	17-2=15

2. Tablodaki verilerden yararlanarak bir problem kuralım.

Örnek Problem

Aysun, harçlıklarından biriktirdiği para ile iki ardeşine hediye, kendisine de bir kazak almak is- r. Aysun ancak 80 YTL biriktirebildiğine göre ardeşlerine neler alabilir? Aysun, annesine de he- ye almaya karar verirse alacağı hediye sayısı na- l değişir?

Tablo: Mağazadaki Fiyatlar

Ürün	Fiyat Aralığı
Kazak	40-60 YTL
Çorap	5-15 YTL
Eldiven	10-20 YTL
Kitap	10-40 YTL
Tişört	20-60 YTL
CD	10-20 YTL
Kolye	5-30 YTL
Pantolon	50-100 YTL

Problem Çözme Stratejileri

- *Deneme yanılma*
- *Şekil, resim, tablo vb. kullanma*
- *Malzeme kullanma*
- *Sistematik bir liste oluşturma*
- *Örüntü arama*
- *Geriye doğru çalışma*
- *Tahmin ve kontrol etme*
- *Varsayımları kullanma*
- *Problemi başka bir biçimde ifade etme*
- *Problemi basitleştirme*
- *Problemin bir bölümünü çözme*
- *Benzer bir problem çözme*
- *Akıl yürütme*
- *Denklem kullanma*

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Notlar: _____

Problem Çözelim ve Kuralım

Isındırma

• Ders kitabında verilen problem çözme stratejileri hakkında öğrencilerin tartışmaları sağlanarak ilgileri çekilir.

• Hangi durumlarda, hangi stratejinin kullanılabileceğine ilişkin örnekler vermeleri istenerek öğrencilerin ön bilgileri ortaya çıkarılır ve problem çözmeye karşı tutumları hakkında bilgi edinilir.

• Bu bölümde "Doğal sayılarla problem kurar ve çözer." kazanımı ünitedeki diğer konularla ilişkilendirilerek işlenmiştir.

• Öğrencilerin problem çözme konusuna odaklanmaları sağlandıktan sonra problemlere geçilir.

Kazandırma

• Ders kitabındaki 1. problem çözümlü olarak verilmiştir. Çözüm aşamalarının öğrenciler tarafından incelenmesi sağlanmalıdır. Bu aşamaların diğer problemlerde de kullanılması yönünde öğrenciler yönlendirilir.

• Problemler çözülürken aşağıdaki uyarılar dikkate alınmalıdır.

! Bir doğal sayının 0 (sıfır) sayısına bölünmesini içeren günlük yaşam durumları inceletilir. Bu durumlardaki anlamsızlık üzerine tartışma yaptırılır.

! Doğal sayılarla ilgili problemler çözülürken bilgi ve beceriler hatırlatılır.

! Program kitabının giriş bölümünde yer alan problem çözme ile ilgili açıklamalar dikkate alınır.

! İşlemlerde gerektiğinde hesap makinesi kullandırılabilir. Bazı hesap makinelerinin işlem sırasının olduğu, bazılarında ise olmadığı, bu nedenle işlem sonuçlarının farklı çıkabileceği belirtilir.

! Birden fazla işlem olduğu durumlarda önce üslü sayılar, sonra parantez içindeki işlemler, daha sonra çarpma veya bölme işlemleri en son olarak da toplama veya çıkarma işlemleri yaptırılır. Aynı önceliklere sahip işlemlerde soldan sağa doğru sıra takip edilir.

• Aşağıdaki işlemler üzerinde işlem sırası uygulanır.

a. $2 + 5.3 + 7.7$

b. $4 + 2^3 + (5-3)$

c. $3^4 + 5 + 12:3$

ç. $3.(5-2) + 4.5$

d. $(8-1).(7-4) - 5-4$

• İşlem sırası öncelik taşıyan işlemler paranteze alınacak olası karışıklıklar önlenebilir.

Uygulama

• Ders kitabındaki problemleri bireysel olarak çözmeleri istenir.

• Öğrenciler çalışma kitaplarının 43. sayfasında yer alan "Problem Çözelim ve Kuralım" başlığı altındaki problemleri matematik defterlerine çözmeleri için yönlendirilir.

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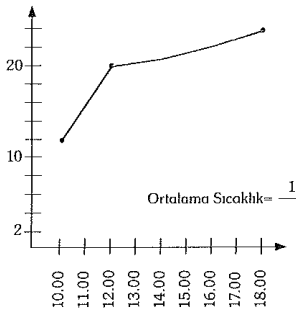
Ders kitabındaki problemlerin cevapları:

3. Saat Sıcaklık (°C)
10.00 12 °C
12.00 +8 20 °C
18.00 +4 24 °C

Grafik: Sıcaklık Değişimi (°C)



Saat	Sıcaklık
10.00	12 °C
11.00	16 °C
12.00	20 °C
13.00	21 °C
14.00	21,5 °C
15.00	22,5 °C
16.00	23 °C
17.00	23,5 °C
18.00	24 °C

Ortalama Sıcaklık= $\frac{12+16+20+22+22+23+24+24+24}{9}$

Bu soruda hesap makinesi kullanılabilir. Yürütmeli bölme işlemi yapılmamalıdır. Yaklaşık sıcaklık değerleri kullanılacağı için bu soruda her öğrenci farklı sonuca ulaşabilir.

4. • 3. molada deniz seviyesinin altına inilmiştir.
• (+5)-(-7)=12 m derine inilmiştir.

5. 5 arkadaşının yaş ortalaması 24 olduğuna göre yaşlarının toplamı 24x5=120 olacaktır.
18 yaşındaki Onur geldiğinde yaşları toplamı
120+18=138 oldu
Daha sonra 28 yaşındaki Erhan gelince yaş ortalaması Şenay ile birlikte 24 olduğuna göre:
(6 arkadaş)+Erhan+Şenay = 24x8=192
(hepsinin yaşları toplamı)
Şenay'ın yaşı = 192 - (138 + 28)
= 192 - 166 = 26

6. Tablo: Gelir Gider Tablosu

Gelir	Gider
+ 712 YTL maaş	- 32 YTL su faturası
+ 724 YTL maaş	- 45 YTL elektrik faturası
+ 100 YTL ikramiye	- 550 YTL kira
	- 64 YTL telefon faturası
	- 300 YTL kredi kartı borcu
	- 80 YTL yakıt parası

(+712)+(+724)+(+100)=+1536 YTL (Gelir)

(-32)+(-45)+(-550)+(-64)+(-300)+(-80)=-1071 YTL (Gider)

(+1536)+(-1071)=+465 YTL

7. 9. sorunun tablosu kullanılarak cevaplanacak bir soru örneği: "2. arabayı metalik renk ve güvenlik paketi ekleyerek kaç YTL'ye alabiliriz?"

8. Her öğrenci farklı problem kuracaktır.

9. Bu açık uçlu bir problemdir. Her öğrenci farklı sonuçlara ulaşacaktır.

DİKKAT

Birden fazla işlem olduğu durumlarda aşağıdaki sıra takip edilir.
1. Üslü sayılar
2. Parantez içindeki işlemler
3. Çarpma veya bölme işlemleri
4. Toplama veya çıkarma işlemleri
Aynı önceliklere sahip işlemlerde soldan sağa doğru sıra takip edilir.

3. Saat 10.00'da hava sıcaklığı 12°C ölçüldü. S 12.00'de hava sıcaklığı 8°C artı. Saat 18.00'de yapı ölçümde ise son ölçüme göre hava sıcaklığının 4°C ort görüldü. Buna göre saat 18.00'deki hava sıcaklığını bu nuz. Saat 10.00 ile 18.00 arasındaki sıcaklık değerişle çizgi grafiği oluşturunuz. Grafik yardımıyla saat başlarınd sıcaklık değerlerini yaklaşık olarak bulunuz. Bu saatler o sındaki ortalama sıcaklığı hesaplayınız. (Hesap makir kullanabilirsiniz.)

4. Bir yer altı mağarasını keşfe çıkan araştırmacılar fa derinliklerde mola vererek ilerlemişlerdir. Tabloda mola yerl nin derinlikleri belirtilmiştir.

Tablo: Keşif Süreci

Molalar	1. Mola	2. Mola	3. Mola	4. Mol
İnilen Derinlikler	17 m	5 m	-7 m	-22 m

✓ İlk hangi molada deniz seviyesinin altına inilmiştir?
✓ 2 ve 3. mola arasında kaç m derine inilmiştir?

Düşünelim

"8 eş bölgeyi 0 (sıfır) eşit gruba ayırsak bir grupta kaç bölge olur?" sorusunun belirttiği durumda anlamsızlık var mıdır? Arkadaşlarınızla tartışınız.

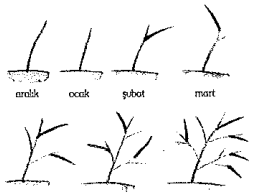
5. Şenay, doğum günü için bir davet verdi. Gelen arkad larından birisi yaşını sorunca yanıt vermek istemedi. Ancak kadaşını kırmamak için birkaç ipucu verdi. Davete gelen ill arkadaşının yaş ortalamasının 24 olduğunu, 18 yaşındaki O geldiğinde yaş ortalamasının 23'e indiğini söyledi. Sonra yaşındaki arkadaşı Erhan geldi ve Şenay kendisini de katt da 8 kişinin yaş ortalamasının 24 olduğunu söyledi. Buna g Şenay'ın yaşını bulabilir misiniz?

6. Okan Bey ve Gülçin Hanım aylık bütçelerini değerler riyorlar. Okan Bey'in maaşı 712, Gülçin Hanım'ın maaşı 7 YTL'dir. Su faturası 32, elektrik faturası 45 YTL tutarında Okan Bey bu ay 100 YTL ikramiye alacak. Kiraları 550 YT telefon faturası 64, kredi kartı borçları 300, yakıt parası YTL'dir. Bu bilgiler ışığında ailenin gelir ve giderlerini göste bir tablo yapınız. Elerinde ne kadar paraları kalacağını hes layınız.

7. Ünite boyunca kitapta yer alan grafik ve tablolardan rarlanarak bir problem kurunuz.

Problem Çözelim ve Kuralım

1. Pınar, aralık ayında bir ağaç fidesi dikti. Fidenin aylara göre gelişimi aşağıda verilmiştir. Temmuz ayında ağacın kaç dalı olacağını bulunuz. Nasıl bulduğunuzu açıklayınız.



Matematik Çalışma Tarih ... /... /.....

2. Yapılan araştırmalara göre saat 20.00 - 22.00 arasında televizyon izleme oranı en yüksek olmaktadır. Bir televizyon yapımcısı en çok seyredilmek istenen programı bu saatler arasında yayınlayacaktır. Ne tür bir programı yayınlayacağını belirlemek için nasıl bir araştırma yapmalı? Bu TV kanalında çalışğınızı düşünerek bu araştırmayı aşağıdaki tablo ve soruların ışığında yapınız. Gerekli grafikleri çiziniz. Sonuçları yazınız.

Tablo: TV Programları

Program	Eğlence	Dizi	Sinema	Spor	Haberler	Belgesel	Müzik
Kadın							
Erkek							

Bu araştırmaya katılanların yaşı, cinsiyeti, sosyoekonomik durumu cevabı etkiler mi? Nasıl? Başka neler etkiler?

3. Erkan, yaşlı Ayşe Hanım'la günlük alışverişlerinde ve işlerinde ona yardım etmek üzere 30 günlüğüne anlaşır. Ayşe Hanım, Erkan'a hafta hafta 10 YTL, 15 YTL, 20 YTL şeklinde artan bir şekilde ödeme yapmayı önerdi. Erkan ise 14 YTL'den başlayarak 2 YTL, 4 YTL, 8 YTL, 16 YTL şeklinde bir ödemenin daha kârlı olacağını düşünüyor. Erkan'ın düşüncesi doğru mu?

). Dördüncü problemdeki verileri kullanarak farklı bir prob- kurunuz.

). Günümüzde otomobil lüks olmaktan çıkıp bir ihtiyaç hâli- gelmiştir. Bununla birlikte herkesin otomobilden beklentileri ıdır. Bir otomobilden beklentilerinize göre 31 000 YTL'niz ağını da düşünerek aşağıdaki seçenekleri değerlendiriniz. ngi otomobili, hangi özelliklerine göre almak istersiniz? Bu : kaç YTL'ye mal olur? Tercihinizi sebebiyle açıklayınız.

Tablo: Otomobillerin Özellikleri

1. Otomobilin Özellikleri	2. Otomobilin Özellikleri	3. Otomobilin Özellikleri
aset çalar, metalik renk, benzinli	klima, CD çalar, sis farı, dizel	klima, kaset çalar, güvenlik paketi, benzinli, otomatik vites
iyatı: 25 000 YTL	Fiyatı: 28 500 YTL	Fiyatı: 28 500 YTL

Ek Özellikler
Klima: 1500 YTL
CD/mp3 çalar: 800 YTL
Otomatik vites: 2000 YTL
Sis farı: 400 YTL
Metalik renk: 500 YTL
Açılır tavan: 1500 YTL
Güvenlik paketi (4 hava yastığı ve fren sistemi): 1000 YTL

Not 1: Peşin alımlarda %5 indirim yapılır.
Not 2: Dizel arabalar yakıt tasarrufu sağlamakla birlikte ngi olan benzinli arabalardan fiyat olarak yaklaşık 2000 TL fazladır.

10. Bir hesap makinesının bölme tuşu bozuk olduğuna göre)24÷16 işlemini nasıl yapabilirsiniz? Yönteminizi açıklayınız.

11. Aşağıdaki örüntünün kaç sayıdan oluştuğunu bulunuz.

1 7 13 19 85

Notlar: _____

Örnek cevap: 28 500 YTL ile 2. araba güvenlik paketi ve açılır tavan ek özellikleri ekletilerek alınabilir.

10. 16'nın katları alınarak sayı bulunur. Örneğin; 10, 100 veya 50 katı alınıp işleme başlanır. Bir strateji geliştirip uygun katlar ile çarpılır. 16'nın kaç katının 1024 olduğu bulunur. Bulunan kat bölünür.

11. Bu örüntü 15 terimden oluşuyor.

Tam Sayılarla İşlemler
(Ders kitabındaki 5. problem)
Merkezî Eğilim ve Yayılma Ölçüleri
(Ders kitabındaki 6. problem)

Kariyer Bilincini Geliştirme
13. Para harcamayı gerektiren uygun amaçları belirler.
14. Parasını uygun biçimde önceliklerini belirleyerek harcar.
(Ders kitabındaki 6. problem)

Tablo ve Grafikler
(Ders kitabındaki 2, 4 ve 9. problem)

Merkezî Eğilim ve Yayılma Ölçüleri
(Ders kitabındaki 5. problem)

Girişimcilik
2. Aileler için bütçe yapmanın önemini örneklerle gösterir. (Ders kitabındaki 6. problem)
3. Gelir ve gider kavramlarının anlamını açıklar. (Ders Kitabı'ndaki 6. problem)

Değerlendirme

• Bu aşamada öğrencilerin doğal sayılar ile ilgili problemleri çözmeleri gerekmektedir.

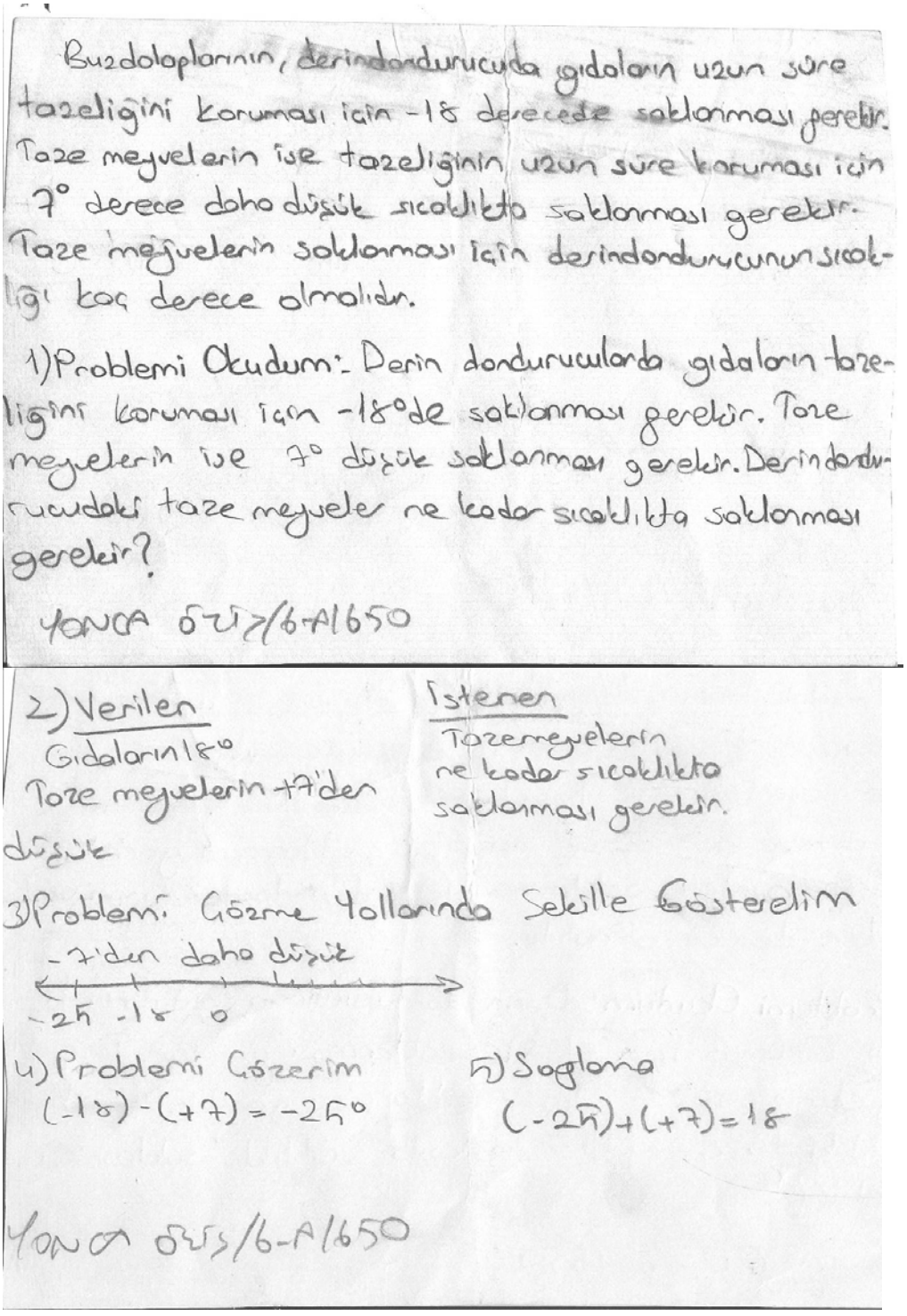
• Öğrencilerden farklı problemler kurmaları istenmelidir. Bu problemleri arkadaşlarına yöneltmelerine fırsat verilmelidir.

• Öğretmen kitabının eklerinde yer alan "Problem Çözme Becerilerini Değerlendirme Formu" doldurulur.

• Konu sonunda öğrencilerin çalışma kitabının 43. sayfasındaki "Matematik Günlüğüm" köşesine işlenen konu ile ilgili duygu ve düşüncelerini yazmaları istenir.

APPENDIX F

SAMPLES OF ACTIVITIES



Buzdolaplarının, derindondurucuda gıdaların uzun süre tazeliğini koruması için -18 derecede saklanması gerekir. Taze meyvelerin ise tazeliğinin uzun süre koruması için 7° derece daha düşük sıcaklıkta saklanması gerekir. Taze meyvelerin saklanması için derindondurucunun sıcaklığı kaç derece olmalıdır.

1) Problemi Okudum:- Derin dondurucularda gıdaların tazeliğini koruması için -18°de saklanması gerekir. Taze meyvelerin ise 7° düşük saklanması gerekir. Derindondurucudaki taze meyveler ne kadar sıcaklıkta saklanması gerekir?

YONCA ÖZÜ/6-A/650

2) Verilen
Gıdaların 18°
Taze meyvelerin +7'den düşük

İstenen
Tazemeyvelerin ne kadar sıcaklıkta saklanması gerekir.

3) Problemi Çözme Yollarında Şekille Gösterelim

4) Problemi Çözerim
(-18) - (+7) = -25°

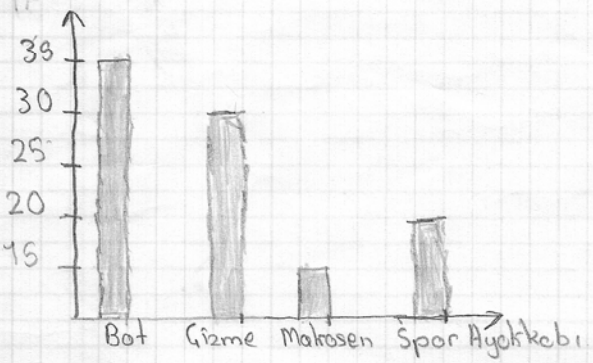
5) Sağlama
(-25) + (+7) = 18

YONCA ÖZÜ/6-A/650

Kare Sovalgeler

Grup üyeleri: Cemre Özgün
Yasin Karatay
Bedran Gerim

Sorular



1)- En çok satış hangi eşyada olmuştur?
BOT'da olmuştur.

2)- En az satış hangi eşyada olmuştur?
Makosende olmuştur

3)- Bot satışı ile Makosen satışı arasındaki fark nedir?
20 olur.

4)- Ortalama satış nedir?
129 olur.