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The Determination of Elementary School Students' Successes in Choosing an Operation and the Strategies They Used While Solving Real-World Problems

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Problem solving takes place not only in mathematics classes but also in real-world. For this reason, a problem and the structure of problem solving, and the enhancing of success in problem solving is a subject which has been studied by any educators. In this direction, the aim of this study is that the strategy used by students in Turkey when solving oral problems and their achievements of choosing operations when solving oral problems has been researched.

In the research, the students have been asked three types of questions made up groups of 5. In the first category, S-problems (standard problems not requiring to determine any strategy but can be easily solved with only the applications of arithmetical operations), in the second category, AS-SA problems (problems that can be solved with the key word of additive operation despite to its being a subtractive operation, and containing the key word of subtractive operation despite to its being an additive operation), and in the third category P-problems (problematic problem) take place.

It is seen that students did not have so much difficulty in S-problems, mistakes were made in determining operations for problem solving because of memorizing certain essential concepts, and the succession rate of students is very low in P-problems. The reasons of these mistakes as a summary are given below:

- Because of memorizing some certain key concepts about operations mistakes have been done in choosing operations.
- Not giving place to problems which has no solution and with incomplete information in mathematics.
- Thinking of students that every problem has a solution since they don't encounter every type of problems in mathematics classes and course books.

Keywords: standard problems (S-problems), word problems, real-world problems, concepts
ZDM Classification: D52
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INTRODUCTION

The aim of this study is that the strategies used by students when solution word problems and their achievements of choosing operations when solution word problems has been researched.

For many people, mathematics consists of lessons that spoil his life and exams that spread fear to his heart and a nightmare that he will get rid of as soon as he finishes school. And for some people mathematics have become a way to understand and love the life. Because the way of love is to understand as it is in everything. We only love things that we can understand. We get a negative attitude to things that we can not understand. People have a negative attitude for mathematics because of that they can not understand mathematics completely. One of the reasons of that negative attitude towards mathematics is that it is very closely related to the confidence which the individual feels about the subject of problem solving. Because of that reason problem solving in mathematics classes is very important (Yıldızlar, 2001).

Problem solving which marked to the age we live, takes place among the purposes of all lessons. It is necessary to know that 21st Century's teaching method is problem solving. For this reason; problem, the structure of problem solving and the increasing of the success in problem solving is a subject which have been researching by many educators and psychologists (Kılıç & Samancı, 2005).

Increasingly complexity social structure and technological advancements, political, social and economical crisis confronts individuals with increasingly problematical situations. Because of this, problem solving is an important subject in psychology which aroused interest for long years. In many researches done in this subject, a lot of concepts have been put forward about problem solving procession. These concepts contain various characteristics from traditional Gestalt approach which is one of the different learning approaches to finally those which are related to computer using and mathematical models.

> While researchers like Gagne (1965) and Skinner (1974) sees individual's background analysis tendency as the most important variable in problem solving process, other researchers, for example, Kohler and Maier (1925, 1970) defended that the most important element in problem solving is individual's perception style of the situation which he confronts (Heppner, 1978).

Individuals who are skilled to solve mathematical word problems can solve the problems that faced in daily life.

To develop problem solving ability on students is one of the most important purposes of mathematics education. And problems are considerably in word form. The in mathematics; Problems having a descript situation or a story in the problem text are called the mathematical word problems. For students' solution word problems it is necessary to understand the text and numerical relations given in the problem, and establish the relations among them. From this respect, word problems provide a good means for understanding mutual interaction of language formation, to reason, and mathematical advancement (Aydoğdu & Oklun, 2004).

Even though algebraic word problems cause to students difficulties for understanding the solutions of equations, they are an important component of mathematics curriculum because of these reasons. The learning of algebraic word problems provides facility for transition from algebra to arithmetic (Dede, 2004). Despite to this, researches done have shown that in majority algebraic word problems are conceived as problems that solutions are found in difficulty (Herscovics & Kieran, 1980; Dede, 2004; MacGregor & Stacey, 1996; Stacey & MacGregor, 2000).

Low & Over (1989) emphasized that whether the information in the problem text are sufficient for solution and determining the information that will help to solution is important for successfully problem solving and expressed that it requires schematic information about the problem. In his research, it came into being that if the information in the problem is sufficient for the solution and students who defined the most important information become successful.

To grow up individuals who can manage to solve possible problems coming in future is one of the prior aims of education. Mathematics educators are like-minded about students' development of problem solving ability and its being one of the leading subjects of education (Charkes & Lester, 1982). Being center of mathematics curriculum, the problem solving gave mathematicians a like-minded importance to the subject. Because understanding mathematical knowledge and forming relation among that knowledge occur in the process of problem solving (Swing, Peterson, 1988). In the problem solving process, students' gathering concepts and operations together and using them in problem solving are expected (Bernardo, 1999). The success of a student in problem solving can be bounded to students' developing of the abilities in problem solving process (Kilpatrick, 1985).

Problem solving in mathematics education has two important products. First, developing of strategies and rules which are special for the teaching subject, the second is developing of thinking ways and general approaches which can be used for developing the formula. By studying in problematic situation, students learn to form new strategies and to solve new type of problems by regulating ancient strategies. In that type of problem solving, it is observed that conceptual and operational knowledge is combined (Olkun & Toluk, 2004). While in operational knowledge the question is to know only how to use it without requiring necessity to know the cause of a concept or an operation, in conceptual knowledge conceiving the situation comes into front (Baki, 1997). Because the conceiving condition takes a part in problem solving, it serves to conceptual knowledge step. Likewise, according to cognitive area theorists comprehending and understanding is important in problem solving. Problem solving is related to individual's background (Kennedy, 1980). A permanent and effective learning in mathematics can only be possible by balancing operational and conceptual knowledge (Baki, 1998).

Educating students to become successful problem solvers has been a goal of education at least since Dewey. However, the kinds of problems students do in school to practice their problem-solving competence have little to do with the problems they will need to solve in everyday settings. School problems posed by textbooks and teachers are typically of a similar type. Algorithmic approaches lead to correct solutions. The students' task is to find that set of algorithms which guarantee the solution and the reward in the form of a good grade. In school-like problems, the answers are already implicated, although they are withheld or concealed by the problem statement. What is offered as knowable (the answer) is prefigured in advance such that actual solution paths can be assessed against this ideal solution Students' tasks are to disclose what the texts (or problems) hide and to find their way through the maze of possible states. The most disconcerting research finding about school problem solving is that there is virtually no carryover to everyday problem solving: there exists a chasm between the problem-solving practices one needs to be successful in schools versus those needed in everyday life (Roth & McGinn, 1997).

In traditional mathematics education understanding, as known, mathematical knowledge is presented and transferred as fragments separated to small parts with a certain construction and regulation by the teacher; then students are asked to repeat and reflect the given information almost identically. In this process, teachers are in a rather active and students are in a rather passive situation. Even though they do not understand this information, students are expected to memorize, repeat and strengthen the known information with given exercises, and in many times when asked similar questions to answer in the way taught before and not to give an extra contribution from their own. Further, a certain response method which is determined before or similar methods are used in answering questions; every question has an only one answer; knowing or finding this answer is the main goal. So, the understanding that students who answer the most question from the shortest and fastest way is the most successful student is one of the dominant and surpassing subjects in educational communities. This general understanding and approach which is pointed out passes from one generation to other as if it is a heritage, how the student thinks when solution problem remains in the background and in the shadows of masses. However, 21 century's informational communities or modern developed countries needs to individual's attaining "new capabilities" by passing some stages beyond basic abilities. In this respect, there are important problems related to students' earnings in mathematics education at school, and one of them is trying to form and solve new problems instead of only solving given problems; and developing necessary capabilities (Korkmaz, Gür & Ersoy, 2004).

In Turkey, pre-university education consists of three stages as being pre-school, the first stage of primary education (1–5), the second stage of primary education (6–8), and secondary education. In this system, there are two important exams determining students' future. They are Secondary Education Institutions Exam and University Exam. The students who answer the questions from the shortest and fastest way in these exams gain the reputation for being the most successful student. For this reason, as being problems first of all, those exams form the biggest obstacle for learning other subjects of mathematics in conceptual level. Those exams cause students to memorize operations and their properties and not to make interpretations about if a problem can be solved or not.

Researches show that many students do not take into consideration real life conditions when solving problems and without thinking about existing or non-existing mathematical relations, they try to solve the given problems just as solving the Standard word problems. (Aydoğdu & Oklun, 2004).

Ample evidence shows a clear tendency of children to neglect realistic considerations and to exclude real-world knowledge from their mathematical problem solving. That is, many students in mathematics classes "understand" and "solve" mathematical word problems without considering the factual relationship between real-world situations (what the problem texts are about) and mathematical operations. Among the evidence documenting students' difficulties and failure in mathematical modeling of word problems are studies showing that, *e.g.*,

- Students frequently solve problems without understanding them students readily "solve" unsolvable, even absurd, problems if presented in ordinary classroom contexts
- Students almost never ask themselves if a problem given to them is solvable or not students frequently use superficial key word methods (or direct translation strategies) rather than thinking deeply about the implied real-world situation when solving stereotyped word problems
- Students' factual problem-solving behavior is heavily influenced by contextual information
- Variations in the "presentational structure" of tasks (changes in wording) dramatically affect problem difficulty
- Students who can easily deal with additive and subtractive problems within the classroom seldom use the formal arithmetic notations when asked to write down

what happened in real-world situations dealing with candy, flowers or dice (Reusser & Stebler, 1997).

When solving problem many of the students may experience difficulty in organizing, systemizing and using knowledge. Especially, in the stage of doing operations when solving mathematical word problems, they can exhibit mistaken approaches. At this point, teachers have important duties in class. Teachers' chance to see the various mistakes of students rises while the students are solving a problem, observing them or making them think loudly or controlling the problems solved by students. Because, it is possible to go to ways providing right points of views according to the analysis of mistakes students do in the stage of problem solving. To evaluate problem solving in class is rather complex and not an easy job. To find a solution of a problem easily is not an evidence of good problem solving abilities. Some students may find right answer by using a wrong logic, on the other hand, some students use perfect strategies but they can not reach to conclusion because of simple mistakes. The aim of problem solving requires thinking in all stages of the process. And this can be a good indication for not knowing problem solving as only an ability to reach conclusion.

The research problems of this study are as follow;

1. Can the students chose the right operation while the word problems?
2. What are the mistakes done by the student while solving the word problems?

METHOD

The Exemplification of the study

The aim of the study is to determine the chosen operation which students use in solving word problems students in Turkish-Education system and the mistakes they do when determining these strategies. With this purpose, a representative sample which can present students in Turkey has been tried to define.

This exemplification carried out by taking one county from each region of Turkey consisting of 6th and 7th grade students. Even though those schools are choused by chance, in the selection of the country, it is tried to choose those which can represent the region.

A total of 485 students composed the exemplification of this research from the countries of Erzurum in East Anatolia Region, Gaziantep in Southeast Anatolia Region, Konya in Interior Anatolia Region, İzmit in Marmara Region, Trabzon in Black Sea Region, Mersin in Akdeniz Region, and İzmir in Aegian Region. Data collection is done in the second term of educational year 2005–2006.

Design

The questions which were asked for determining the strategies that the students in the exemplification developed for using to solve three types of word problems and for determining mistakes done in this process are defined in three categories. The first category consists of standard problems not requiring to determine any strategy but can be easily solved with only the applications of arithmetical operations (S-problems), the second category consists of problems that can be solved with the key word of additive operation despite to its being a subtractive operation, and containing the key word of subtractive operation despite to its being an additive operation (AS-SA), and a "problematic problem" (P-problem) which was "solvable" only on the basis of problematic mathematical modeling assumptions.

Procedure

The problems were presented to students in one mixed series (containing five S-problems, five AS-SA-problems and five P-problems). The students were asked to answer these questions. Students were asked to write their answers and interpretations to the empty spaces in the question paper separated for their answers. Also interviews were made with students and the opinions of students were taken by discussing questions in classes. After the evaluation of the exam, Interviews has been done by taking into account of students' mistakes. In this way, a better determination of the strategies which students formed in solving question and mistakes done in this process was provided. During the application, any kinds of assistance have not been done.

Data Analysis

As in Verschaffel, *et al.* (1994) and Reusser & Stebler (1997), the pupils' answers, computations and comments were coded into five categories.

Expected non-realistic numerical answer (EA): Straightforward application of an arithmetic operation without regard to reality constraints. EA responses lead to correct answers in the S-problems, and to unrealistic ones in the P-problems. EA responses lead to wrong operation determination in AS-SA problems, that is, using subtractive operations while requiring doing operation with additive operation or doing operation with additive operation while requiring doing operation with subtractive operation.

Technical error (TE): Answer structure like EA but in addition with a technical mistake in the execution of arithmetic operations.

Realistic answer (RA): Answer based on realistic considerations, *i.e.*, on real-world

knowledge activated while understanding and solving the problem.
No answer (NA): Neither a numerical answer nor a comment on the task is given.
Other answers (OA): Answers not classifiable into other categories.

The above coding was made according to the first letter of the related words.

Table 1. The Problems Presented in the Research

S-Problems	
S1	Akın wants to play a game. He calls 3 girl and 6 boy friends to play. How many friends has Akın got in total in this game?
S2	Çağrı took 50 liras from his father and 15 liras from his mother. How much Money has Çağrı got in total?
S3	A man cuts a clothes line of I2 m into pieces of I .5 m each. How many pieces does he get? (Reusser & Stebler, 1997).
S4	Ayşe's piggy bank contains 750 YTL. He spends all that money to buy pencils. How much was the price of one pencil?
S5	This flask is being filled from a tap at a constant rate. If the depth of the water is 4 cm after 10 sec. How deep will it be after 30 set? (Drawing of a cylindrically shaped flask) (Reusser & Stebler, 1997).
AS and SA-Problems	
AS1.	The cakes which Yağmur made for her friends are 17 pieces in total. 4 of them remained. How many pieces were eaten? (Aydoğdu & Oklun, 2004).
SA2.	When Funda's 8 buckles subtracted 7 pieces remain. How many buckles has Funda got? (Aydoğdu & Oklun, 2004).
SA3.	When Ali gives 5 of his pencils to his friend 9 pencils remains back. According to this, find the number of the Ali's pencils in the beginning.
AS4.	When İlknur takes 4 pencils from her sister and 5 pencils from her friend she has 19 pencils in total. How many pencils has İlknur got in the beginning?
SA5.	Burak gives 9 marbles to Ali, and 7 marbles to Ahmet. And as Burak's 15 marbles remained back, how many marbles did he have in the beginning?

Continued.

P-Problems

P1. John's record time to run 100 m is 17 sec. How long will it take him to run 1 km? (Greer, 1993)

P2. A man wants to have a rope long enough to stretch between two poles 12 m apart, but he has only pieces of rope each 1.5 m long. How many of these pieces would he need to tie together to make the rope long enough to stretch between the poles? (Greer, 1993)

P3. This flask is being filled from a tap at a constant rate. If the depth of the water is 4 cm after 10 sec., how deep will it be after 30 set? (Drawing of a cone-shaped flask) (Greer, 1993).

P4. Bruce and Alice go to the same school. Bruce lives at a distance of 17 km from the school and Alice at 8 km. How far do Bruce and Alice live from each other? (Reusser & Stebler, 1997).

P5. 450 soldiers must be bused to their training site. Each army bus can hold 36 soldiers. How many buses are needed? (Carpenter, Lindquist, Matthews & Silver, 1983)

Findings

S-Problems

As Table 2 shows, pupils performed rather well on the standard problems. That is, the students participated to this exemplification did not experienced so much difficulty in solving of standard word problems.

Table 2. Percentages of Students' Solutions of the Five S-Problems

	S1	S2	S3	S4	S5
EA: Correct solutions	96.7	98.9	56.7	77.1	57.1
TE: Technical error	0.6	0.2	4.7	4.9	3
NA: No answer	0.4	0.4	10.1	4.1	11.5
OA: Other answer	2.6	0.4	28.4	14.2	28.2

As expected, and in accordance with the studies of Verschaffel, *et al.* (1994) & Reusser, Stebler (1997). In Verschaffel, *et al.* (1994), EA rate 84.00%, in the Reusser & Stebler (1997), this rate was 73.00%, and EA in this study was 77.30%.

AS-SA Problems

As Table 3 shows, the students participated to this exemplification did not experience so much difficulty in solving of AS-SA problems. But as Table 3 shows, pupils to make a fault operation determination in AS-SA problems.

Table 3. Percentages of Students' Solutions of the Five AS-SA Problems

	AS1	SA2	SA3	AS4	SA5
EA: Wrong Operation Determination	18.3	17.7	17.3	22.8	25.7
TE: Wrong Operation	0.2	0. 4	0.0	0.0	0.4
RA: Correct Answer	80.4	80.,4	82.4	74.6	72.3
NA: No answer	1.0	0.4	0.0	1.2	1.4
OA: Other answer	0.0	0.4	0.2	1.2	0.0

As it is seen from Table 3, 20.36% of the students did fault operation determination when doing AS-SA problems. From the interviews done with the students, the reason of the mistake was seen as identifying certain concepts with certain operations. For example, since the student identified "more" with additive operations, he does additive operation in every problem in which he sees "more." Two of the interviews done about this subject are as below;

In the respond to the question "The cakes which Yağmur made for her friends are 17 pieces in total. 4 of them remained. How many pieces were eaten?" (AS1), the student Ali's answering was that 17 + 4 = 21, the interview done with this student is like below:

R: When answering this question you added 17 with 4. Why?
S: Yes, yes. (He says there is a remainder in the question.)
R: Did you do additive operation because there is a remainder in the question?
S: Remaining means increasing. (Our teacher said when there is increasing use additive operation.)
R: You say that when you see the words "much, more, I took, remained, too much" you must use additive operation.
S: Yes, when we see much, surplus, remained words we do additive operation.

In the respond to the question "When Funda's 8 buckles subtracted 7 pieces remain. How many buckles has Funda got?" (AS2), Nalan's answering was that 8 – 7 = 1, the interview done with this student is as below:

R: When answering this question you subtracted 7 from 8. Why?
S: Because Funda's buckles are decreasing.

R: What is happening when Funda's buckles are decreased?
S: Funda's buckles are decreasing. When there is a decrease, we do subtraction.
R: For whatever words do you do subtractive operation like decrease?
S: When he gives apples, when apples are subtracted, when apples are decreased, we do subtraction operation.

As it is observed from the interviews done, it is seen that students do additive operation looking to "remainder," or do subtractive operation looking to "decrease." Further; he states that the teacher have told to do additive operation when there are the words that "much, surplus and remainder".

P-Problems

The success in the P-problems is rather low comparing to S and SA-AS problems. Especially, the Answering rates which expected generally but not being true is rather high.

Table 4 shows the expected non-realistic, and a subset of realistic responses for each of the five P-problems.

Table 4. Expected Non-Realistic and Realistic Responses to the five P-problems

Expected non-realistic answer (EA)	Realistic answer or response (RA)
P1 $10 \times 17 = 170$; 170 sec = 2 min 50 sec	Cannot be known because of fatigue of the runner About 3 and a half minutes Certainly more than 170 seconds
P2 $12 : 1.5 = 8$ pieces are needed	Certainly more than 8 pieces
P3. $3 \times 4 = 12$ (cm)	A precise answer is not possible. Because cone-shaped flask is cone.
P4. $17 + 8 = 25$ or $17 - 8 = 9$	Cannot be known because of relative distance to school and to each other
P5. $450 : 36 = 12.5$ buses are needed	13 buses are needed if you do not use buses twice

The evaluations of P-problems have been done in a little different style from other problems' evaluations.

The numerical answers given by the pupils, their qualifying comments and remarks were also analyzed in order to determine whether or not real-world knowledge had been activated during the solving of a specific problem. If a comment of a student revealed a sign of a more realistic understanding of a problem, *i.e.*, a problem model that was more authentic than the impoverished one underlying the unrealistic answer, a "+" mark was added to the answer category. If no such mark was found the response code was followed by a "–" mark. Because the numerical answers and calculations were coded independently of the verbal comments, the "+" mark can be associated to any of the categories mentioned above (Reusser & Stebler, 1997).

Table 5 reveals the results for the ten problematic problems according to the category system described above. For every P-problem the total number of "realistic reactions" (RR), *i.e.*, reactions mirroring the activation of real-world knowledge, was computed. The sum of RRs thus refers to all reactions per problem that were coded as "realistic", either with regard to the numerical answer (RA) or to an additional qualifying comment (indicated by a "+" mark).

Table 5. Percentages of Responses

	P1	P2	P3	P4	P5	Total (P1–5)
EA+	5.5	3.3	0.,0	2.4	0.0	11.2
EA–	45.4	51.9	51.3	85.2	53.1	
TE+	0.0	0.0	1.7	0.0	5.3	7
TE–	8.2	4.1	3.2	0.0	0.0	
RA+	0.0	0.8	0.4	0.0	14.6	15.8
RA–	0.0	0.0	0.0	0.0	0.0	
NA+	4.0	5.7	5.9	3.5	4.3	23.4
NA–	11.14	14.9	10.5	3.3	8.0	
OA+	4.3	2.8	7.3	3.4	6.7	24.5
OA–	21	16.3	19.5	2.1	7.5	
RR	13.8	12.6	15.3	9.3	30.9	16.38

In the Verschaffel, *et al.* (1994) study which was done before, RR rate 17.1%, in the Reusser & Stebler (1997) study while this rate was 18.5%, the RR rate in this study was 16.38%. As it is seen from these results, the results of this study and the other similar studies have done before shows a parallelism.

By creating a discussion environment in class about P-problems, students' opinions about this subject were tried to be taken in a better way. The discussions about P2 and P4 problems are like below:

Problem P2

First students were asked to solve P2 (Certainly more than 8 pieces) again in their notebooks.

And then it is asked who did the expected but non-realistic answer that 12 : 1.5=8. Approximately more than 50% of the class raised their hands and said that they found this answer. 8 piece of rope each 1.5 m long which were brought by the teacher to the class were given to a student and he was asked to tie stretch to a between two poles 12 m apart. When the student couldn't do this job with the rope in his hand, he said that he needs much more rope. In this way, they saw the mistake they did before. They said all together that when binding the rope together, they must consider the expended quantities. And after the students said that the question was not difficult in fact, but a little more carefully thinking was necessary.

Problem P4

The process in P2 problem was followed. If the answering of students that 17+8=25 and 17–8 = 9 is true or not was asked. The places of school and home were discussed with students. One of the probabilities; on the condition that houses are in the same direction, the points in houses and school exist can make a straight, the other probability is that being that the houses in opposite directions, the points in which the houses and school exist can make a straight, the other probability is that the points in which the houses and school exist can make a triangle. After these probabilities are discussed, they are asked to answer this question. The majority of the students told that they can not say a definite thing with this information. Even there were those who said that this question was false.

Why so much mistake was done with these questions, why operation was done without looking if the question will be solved or not. The answers student given to these questions were as below:

- We never saw such problems before. We never solved these problems neither in our books nor in our lessons.
- When we see a problem, by considering numerical data's in the problem, we think that we must do arithmetic operations with these.
- Since all the problems we solve in the lessons have solutions, we never think about problems with no solution.

- We never think that a problem can be with no-solution.
- From now on, I will do this kind of problems easily. Because I know that it can be with no-solution.
- We saw that that type of problems are not difficult, but the important thing is to know that it can be unsolvable.

Discussion and Conclusions

When considered the findings obtained; Students' success rates in S-type problems are merely high, their success rates are high in AS-SA problems but a major mistake has been done in the same question (20.36%) in determining the operation to be done. And lastly in P type problems their success rates are rather low.

It is seen that students do not have difficulty when answering Standard problems that not requiring determining any strategy but can be solved with only the application of arithmetic operations. It can be said that the reason for the low success rate in S3 and S5 problems can be respectively that not being able to do division operation in decimal numbers and not being able to set up ratio. That is, students do not have much problem in practicing arithmetic operation knowledge. When considered the results of the study, we can say that in general students do not have difficulty in operations but they have difficulty in conceptual operation which requiring interpretation. Our results obtained this study "For students the main difficult thing is to learn concepts about the subjects told, not to learn algorithmic calculations. Despite to this, being American students at the top, almost every student's mathematical experiences over the world consist of only calculations (Sabella & Redish, 1995)." It shows accommodation with studies like.

In the findings part again, it is seen that key word approach mistakes students in problems that can be solved with subtractive operation although it contains the key word about additive operation, and can be solved with additive operation although it contains the key word about subtractive operation. Even it can be said that it prevent children to advance in that area. The true answer rates in AS-SA problems are rather high as in S-problems (78.02%). But a majority of the mistakes done in the same question (20.36%) is the mistakes in determining the operations to be done. As understood from the interviews done with the students, they consider the key words when determining the operation kind. That is, when they see the concepts like "more, took, remained" they immediately do additive operation, and when they see concepts like "reduced, lessened, gave" they immediately do subtractive operation. Instead of memorizing students the key words about operations, they must be given possibilities for creating their own problem solving strategies. When it is not done, students do operation using the key words they memorized, and naturally they make mistakes. Also, memorizing key words hinders students' intellectual development, and their developing own strategies in problem solving. For students' not falling to mistake, mathematical models should take place instead of memorizing certain key concepts, as expected and in accordance with Verschaffel *et al.* (1994) and Reusser & Stebler (1997).

It is seen that student's success rate is rather low in P-problems that not solved with mathematical operations quickly, but needs mathematical models and interpretations beside it. RA answer rates in P-problems are only 3.16%. From the discussions made in class, it is understood that students never come across with such problems before. When asked if the questions are understood completely, they say that they understood them but they think those must be solved too since all the problems they saw up to now have a solution. Because such problems are not encountered before, they solved the questions without regarding if the questions are solved, or any lacking information exists or not. When concrete materials brought about P2 question and when solution is done with these, students saw that their solution is wrong by immediately realizing this condition.

Because of this, in mathematics classes, in learning process every kind of problem must take place and time must be given for students developing their own problem solving strategies, and benefit from concrete means. Also that such problem does not take place in course books is stated by students. For this, problem types with no solution and lacking information must take place in books. Students' intellectual development can be provide and their problem solving abilities can develop by giving place in mathematics classes and course books to standard word problems, problems which can be solved with subtractive operation although it contains the key word of additive operation and additive operation although it contains the key word of subtractive operation, and problems which have no solution and lacking information. In this way, students who encounter such problems and can solve them will also have no difficulty in solving problems that they will encounter in real life.

REFERENCES

Aydoğdu, T. & Olkun, S. (2004). İlköğretim öğrencilerinin toplama-çıkarma içeren standart sözel problemlerde işlem seçme başarıları. *Eurasian Journal of Educational Research* **16**, 27–38.

Baki, A. (1997). Educating mathematics teachers. *Medical Journal of Islamic Academy of Sciences* **10** (**3**).

Baki, A. (1998). *Matematik öğretiminde işlemsel ve kavramsal bilginin dengelenmesi*, Atatürk Ünv., 40. Kuruluş Yıldönümü Matematik Sempozyumu, Erzurum,.

Bernardo, A. B. (1999). Overcoming obstacles in understanding and solving word problems in mathematics. *Educational Psychology* **19**(**2**), 149–163.

Carpenter, T. P.; Lindquist. M.; Matthews, W. & Silver. E. A. (1983). Results of the third NAEP mathematics assessment: Secondary school. *Mathematics Teacher* **76(9)**, 652–659. MATHDI **1984x.**00303

Charles R. & Lester, F. (1982). *Teaching problem solving; What, Why & How.* Palo Alto, CA: Dale Seymour Publications. MATHDI **1983l.**03288

Çakmak, M. (2003). *Matematik Derslerinde Problem Çözme Yaklaşımının Değerlendirilmesi.* Matematikçiler Derneği Bilim Köşesi. Available from: http://www.matder.org.tr/

Dede, Y. (2004). Öğrencilerin Cebirsel Sözel Problemleri Denklem Olarak Yazarken Kullandıkları Stratejilerin Belirlenmesi. Matematikçiler Derneği Bilim Köşesi. www.matder.org.tr.

Greer, B. (1993). The Mathematical modeling perspective on Word Problems. *The Journal of Mathematical Behavior* **12(3)**, 239–250. MATHDI **1995c.**01778

Heppner, P. (1978). A Review of the Problem Solving Literature and Its Relationship to the Counseling Process. *Journal of Counseling Psychology* **25(5)**, 366–375. ERIC EJ220890

Herscovics, N. & Kieran, C. (1980). Constructing Meaning for the Concept of Equation. *Mathematics Teacher* **73(8)**, 572–580. MATHDI **1981x.**02222

Kılıç, D. & Samancı, O. (2005). "İlköğretim okullarında okutulan sosyal bilgiler dersinde problem çözme yönteminin kullanılışı". *Kazım Karabekir Eğitim Fakültesi Dergisi*, Sayı: **11**, 100–112.

Korkmaz, E., Gür, H. & Ersoy, Y. (2004). *Problem Kurma Ve Çözme Yaklaşımlı Matematik Öğretimi-II*: Öğretmen Adaylarının Alışkanlıkları Ve Görüşleri, Matematikçiler Derneği Bilim Köşesi. Available from: http://www.matder.org.tr/

Low, R. & Over, R. (1989). Detection of missing and irrelevant information within algebraic story problems". *British Journal of Educational Psychology* **59(3)**, 296–305. MATHDI **1991h.**02153

MacGregor, M. & Stacey, K. (1996). Learning to Formulate Equations for Problems. 20th Conference of the International Group for the Psychology of Mathematics Education (PME 20). Proceedings. Vol. 3. In: Puig, L.; Gutierrez, A. (Eds.), Valencia Univ. (Spain). Dept. de Didactica de la Matematica 1996. pp. 289–296 of p. 429 Available from FIZ Karlsruhe. Conference: 20. annual meeting of the International Group of the Psychology of Mathematics Education (PME), Valencia (Spain), 9–12 Jul 1996 Mayer, R. E. (1982): The Psychology of Mathematical problem solving. In: F. K. Lester & Garofalo(Eds.), *Mathematical problem solving: Issues in research* (1–13). Philadelpia:Franklin Institute Press. MATHDI **1997c.**02011

Mayer, R. E. (1982). The Psychology of Mathematical problem solving. In: F. K. Lester & Garofalo (Eds.), *Mathematical problem solving: Issues in research* (1–13). Philadelpia: Franklin Institute Press.

Olkun, S. & Toluk, Z. (2004). *İlköğretimde Etkinlik Temelli Matematik Öğretimi.* Anı Yayıncılık, Ertem Matbaacılık, s.44, Ankara.

Roth, W. M. & McGinn, M. K. (1997). Toward A New Perspective on Problem Solving. *Canadıan Journal of Educatıon* **22(1)**, 18–32. ERIC EJ550076

Reusser, K. & Stebler, R. (1997). Every word problem has a solution – The social rationality of mathematical modeling in schools. *Learning and Instruction* **7(4)**, 309–327. MATHDI **1998e.**03646

Sabella, M. S. & Redish, E. F. (1995). "Student understanding of topics in linear algebra". *Physics Education Research Group University of Maryland Physics Department College Park* 1–6.

Stacey, K. & MacGregor, M. (2000). Learning the Algebraic Method of Solving Problems. *Journal of Mathematical Behavior* **18** **(2)**, 149–167. MATHDI **2002c.**02207

Swings, S. & Peterson, P. (1988). Elaborative and integrative thought processes in mathematics learning. *Journal of Educational Psychology* **80(1)**, 54–66.

Verschaffel, L.; De Corte, E. & Lasure, S. (1994). Realistic considerations in mathematical modeling of school arithmetic word problems. *Lenrnrng and Instruction* **4**, 273–294.

Yıldızlar, M. (2001). "Matematik Problemlerini Çözebilme Yöntemleri". *Eylül Kitap ve Yayınevi, Ankara*, 6–36.