Operational and Measurable Prediction Strategies and Their Usage[1]

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Abstract

This study aimed to determine the eighth grade primary school students' strategies used in prediction math problems with measurement tools. The study was conducted with 221 eighth grade students from twenty state schools which were selected with stratified random selection process among the state schools of an East Anatolian city of Turkey in the academic year, 2011-2012. The data were collected with the "Operational and Measurable Prediction Skill Test" including ten questions. The analysis showed that the students used ten strategies about operational and measurable prediction skills. These strategies were categorised as follow: rounding, grouping, operation according to first and last digits, revision-correction, operation based on experience, mental operation, random prediction, visualization, inductive strategy, and comparison strategy.

Keywords

Prediction, Measurable Prediction, Operational Prediction, Strategy.

Introduction

Thinking is the skill of inference from events and rearranging them according to the individual's own interests and then it is the most distinctive characteristic that distinguish human from other creatures. While teaching numbers, operations, algebra, geometry, proportion, area measurement and many topics of mathematics, mathematics also teaches the individual discovering patterns, reasoning, predicting, reasonable thinking and reaching result.

Therefore, mathematics is one of the foremost parts and maybe accepted as the most important one of fundamental education. Mathematics education teaches much than numbers, operations and calculating skills which is the indispensable part of daily life, and it also gives other important skills such as thinking, connecting between events, making inference, predicting, problems solving as well

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(Umay, 2003). Recent information and technologies constantly change the way of mathematics and communication. As a natural product of these changes, the importance of calculating by using paper and pencil is gradually decreasing and prediction and problem solving skills are taking its place as a result (MEB, 2005). One of the important functions of the prediction is its role in checking the result of the accurate calculation. In other words, it enables us to find the interval of the accurate answer. Prediction as a frequently used tool in both daily life and scientific processes is sometimes as practical as real measurements (MEB, 2009).

Therefore, students should have gained some skill such as critical handling of the problems, making inference, evaluation the issue and making a prediction on an actual event in order to overcome the difficulties that they face in daily life. Prediction as one of these skills is one of the fundamental skills that eases our life (Aslan, 2011). Skill of prediction in mathematics has a significant place. Predicting some or all part of the solution is not a random process. It is highly dependent on the individual's mathematical knowledge (Olkun and Toluk, 2003, p. 39). Considering this issue, Ministry of National Education of Turkey gave much place to the skills of intellectual operation and making prediction related to four basic operations in 6.-8.Grade Elementary Mathematics Curricula of Turkey. The curricula highlight the importance of "The Development of Prediction Skill" and give much place to the activities about this field in the educational sources. Then, the skill of prediction is aimed to be given and developed in many ways such as making prediction based on the data, making prediction on in the result of fractions and decimal fractions, peripheral length of planar figures, area prediction of planar area and prediction in volume (Tekinkır, 2008).

Prediction and the Skill of Prediction

Although the prediction is defined differently in many resources, the common point of these definitions (Dowker, 1992; Luwel and Verschaffel, 2008; McIntosh, Reys, Reys, Bana and Farrell 1997; Montague and van Garderen 2003; Reys, 1986) is the prediction is a kind of calculation which is done without using paper and pencil, and does not reach and accurate result (Aslan, 2011). The prediction used in many areas is categorised in three ways in mathematics education. These are as follow: cumulative prediction (Aslan, 2011; Hanson and Hogan, 2000; Sowder, 1992; Tekinkır, 2008), measurable prediction (Aslan, 2011; Tekinkır, 2008); and operational prediction (Aslan, 2011; MEB, 2009; Dowker, 1992; Heinrich 1998; McIntosh, Reys, Reys, Bana and Farrell 1997; Muır, 2005; Sowder 1992; Tekinkır 2008).

The prediction is commonly used in daily life by both children and adults. In daily life, the prediction questions such as "How much time do I spend while reaching home? What is the total cost of the shopping basket? How much weight is this object? How many meters are there between these two objects?" can be easily asked.

The predictions can be right or wrong; the event can be resulted as it is supposed or not; but the prediction is a skill that is needed to be developed in students (Kılıç, 2003). Each individual having a mathematical literacy should be able to make a judgement on plausibility and accuracy of the result based on the prediction of probable solutions and decides properly (Aslan, 2011). In daily life, one can not carry the measurement tools all the time and then the skill of prediction is a necessary skill for the individual. With the studies conducted after 1980 (Aslan 2011; Baroody and Gatzke 1991: Berry, 1998; Carpenter, Coburn and Reys, 1976; Dowker 1997; Dowker et al. 1996; Forrester and Latham. 1990; Forrester and Beatrice, 1995; Heinrich 1998; Levine 1982; Luwel and Verschaffel 2008; MEB, 2005; Montague and van Garderen 2003; Mottram 1995; Munakata 2002; Reys and Yang 1998; Reys, Reys, and Penafiel 1991; Sowder 1992; Sowder and Wheeler, 1989; Sulak 2008; Tekinkır, 2008; Yazgan, Bintaş and Altun 2001), the importance of the prediction skill has been emphasised and

education programmes have been developed in order to give place to regular, systematic and constant prediction activities in mathematics education curricula (Sowder, 1992). The skill of prediction is not only necessary for just a few vocations and daily life activities, it is also important for the development of many mathematical skill such as mental activities, spatial visualizations, understanding measurements and numbers (Brade, 2003). The question, "If we have to measure everything faultlessly, how will the life be?" (Muır, 2005, p.2) emphasises the significance of the skill of prediction having a probable skill in their mind as it is not easy to have a measurement tool when they need. In addition, with the fast developing technology error margin and risk analyse is gaining importance, and then it is important have the skill of prediction which can be accepted as the fundamental of these topic for individuals' sustaining the life efficiently in the future.

This study investigates the prediction strategies of eighth grade students' operational and measurable prediction strategies that they use. It is thought that the determined strategies will be important for creating and developing the skill of prediction in students in new educational approach.

The aim of this study is to determine eighth grade elementary students' operational and measurable prediction strategies that they use. Below sub-questions related to this aim were asked in the study.

1. What is the frequency of the students' strategy use in prediction problems?
2. What are the students' operational prediction strategies which they use in prediction problems?
3. What are the students' measurable prediction strategies which they use in prediction problems?

Method

Research Design

In this study, determining eighth grade elementary students' operational and measurable prediction strategies which they use in the course was aimed. A case study research design which lets researchers investigate a case, event or issue in detail (McMillan, 2000) was adopted for fulfilling this aim.

The Participants of the Study

The participants of the study were comprised of 221 eighth grade students from 20 elementary schools located in East Anatolian Region of Turkey. 112 students were female and the rest, 109 students were male students in the study.

Data Collection Tools and Data Analysis Method

The data in the study were collected with a "Prediction Skill Test (PST)" which has 10 open-ended questions and was used in the studies of Mottram (1995) and Munakata (2002). Below steps were applied in the process of test application.

I. Sixth, Seventh and Eighth grade mathematics education curricula were analysed for determining the outcomes related to the prediction. The operational and measurable prediction questions were prepared with the use of relevant course books.

II. Three elementary mathematics teachers evaluated the test and their opinions were taken for face and content validity. Later, two experts in the mathematics area evaluated the test. Lastly, two Turkish language teachers checked the test for proper language use.

III. The test was applied to 24 students and the students were informed about the aim of test application and the study. The pilot study application lasted in 20 minutes. During the application, the students' questions were noted, the reasons of their questions were asked and necessary revisions were made.

IV. After revisions, the new test was applied to 20 students and any questions were asked about the test. For the test reliability, Cronbach Alpha technique was used and the test was applied to 20 elementary schools for the main study.

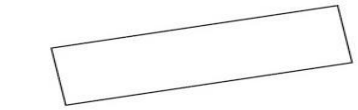
The questions in the test were presented below and the words after the numbers of the questions "operational, measurable" were not given in the main application process.

Question-1. (Operational)

$6\frac{4}{19} : 3\frac{9}{11} =$

If you want to predict the result of this mathematical operation, how do you answer it? Please, predict the answer according to your way of solution.

Question-2. (Measurable)



Verilen dikdörtgenin %60'ını tahmin etmek isterseniz nasıl bir yol izlersiniz? Bulduğumunuz bu yola göre şeklin % 60'ını tahmin ediniz?

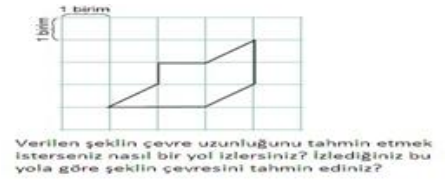
If you want to predict 60% of this rectangle, how do you answer it? Please, predict 60% of the figure according to your way of answer.

Question-3. (Operational)

$12\frac{3}{17} + 5\frac{8}{9} =$

If you want to predict the result of this mathematical operation, how do you answer it? Please, predict the answer according to your way of solution.

Question-4. (Measurable)



Verilen şeklin çevre uzunluğunu tahmin etmek isterseniz nasıl bir yol izlersiniz? İzlediğiniz bu yola göre şeklin çevresini tahmin ediniz?

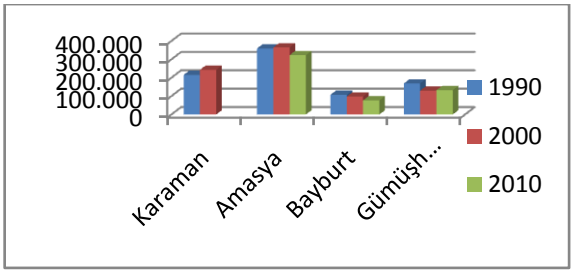
If you want to predict peripheral length of the figure, how do you answer it? Please, predict the peripheral length of the figure according to your way of answer?

Question-5. (Operational)

7, 098. 5, 61 =

If you want to predict the result of this mathematical operation, how do you answer it? Please, predict the answer according to your way of solution.

Question-6. (Measurable)



Four cities' population numbers in years 1990, 2000 and 2010 are given but the city, Karaman's population number in the year 2010 is not given in the graph. If you want to predict the population of Karaman in 2010 according to the graph, how do you answer it?

Question-7. (Operational)

24, 708 – 9,006 =

If you want to predict the result of this mathematical operation, how do you answer it? Please, predict the answer according to your way of solution.

Question-8. (Measurable)



If you want to predict the number of unit cubes that unite the above prisms, how do you answer it? Please, predict the number of unit cubes according to your way of answer.

Question-9. (Operational)



If you want to fill in the square prism with sand via the cube figure, how do you predict when the square prism is filled? Please, predict the answer according to your way of prediction.

Question-10. (Measurable)



If you accept the area of the above figure as 1 cm², how do you predict the area of the figures? Please, predict the area of the figures according to your way of prediction.

Data Collection

In the first step, the permissions from the relevant institutions for the application were taken and the mathematics teachers of the schools were informed about the application. The test was applied to

students in the class during a course hour period. At the beginning, the students were told about the aim and significance of the study, and emphasised the difference of the test that they were acquainted with before. While answering the prediction test, their ways of solution were taken orally and also explained in the test. In addition, they were informed about painting of 60% of the figure in the second question of the test.

Data Analysis

After data collection process, the papers were numbered by the researchers and transformed into the data analysis programme. In data analysis process, two researchers collaborated and each student answer was checked by the researchers together. Operational and measureable prediction strategies ad their sub-dimensions were categorised with collaboration. Data analysis of each sub-question was conducted as follows:

In the first sub-question, determining the numbers of students' operational and measureable prediction strategies use were aimed and descriptive analyses were conducted based on this aim.

In the second sub-question, students' operational prediction strategies were investigated within the strategies: Operation according to first and last digits, Random prediction, Operation based on experience, Rounding, Mental operation, Grouping, Revision-correction and Distribution. Therefore, descriptive analyses were conducted for gathering frequencies and percentages of each sub-strategy and also relevant student excerpts were determined in this process.

In the second sub-question, students' measurable prediction strategies were investigated within the strategies: Visualization, Random prediction, Operation based on experience, Inductive, Comparison and Revision-correction. Descriptive analyses were conducted with regards to each sub-strategy for gathering frequencies and percentages of each sub-strategy and also relevant student excerpts were also determined in this process, too.

Findings

In this section, the findings about the sub-questions were presented one by one and the findings were interpreted and supported with quotations.

Findings With Regards to the First Sub-Question

The findings about the numbers and percentages of predicted and used operational and measurable prediction strategies in prediction skill test were presented in Table 1.

Table 1. Numbers and percentages of predicted and used operational and measurable prediction strategies in prediction skill test

	Operational	*Measurable*	*Total*
Number of students	221		221
Number of questions	5	5	10
A=Number of predicted strategy use	5x221=1105	5x221=1105	2210
B= Number of used strategy use	326	249	575
A-B	779	856	1635
A/B percentage	29,5	22,5	26,01

As it is shown in Table 1, operational prediction strategies were mostly used by students. Only operational strategy use was adopted 326 times from the expected 1105 times. Then this strategy was not used 779 times. In the same way, measurable strategy use was adopted 249 times from the expected 1105 and then it was not used 856 times. The total strategy use is 26,01%.

Findings With Regards to the Second Sub-Question

The findings about the students' operational prediction strategies and the numbers and percentages of these strategies were presented in Table 2.

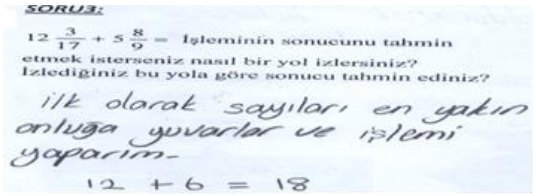
Table 2. Used operational prediction strategies and their numbers and percentages

Operational prediction strategies	*n*	*%*
Operation according to first and last digits	110	33,74
Random prediction	91	27,92
Operation based on experience	52	15,95
Rounding	36	11,04
Mental operation	25	7,67
Grouping	5	1,53
Revision-correction	4	1,23
Distribution	3	0,92
Total	326	100

The students used the strategy "Operation according to first and last digits" (33,74%) most, and "Distribution strategy" (0,92%) less. In addition, the students used six more strategies in different percentages. The total eight strategies and the students' quotations about these strategies were given below systematically with the photographs.

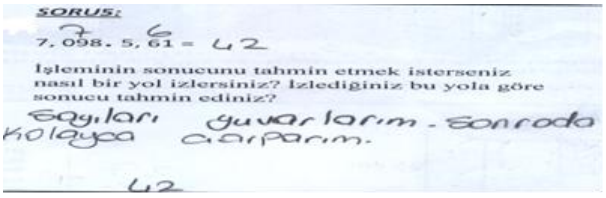
Rounding Strategy

This strategy includes rounding the number to 10 or 5, and sometimes rounding the unit digits or the whole numbers in decimal fractions.


SORU3:
$12\frac{3}{17} + 5\frac{8}{9}$ = İşleminin sonucunu tahmin etmek isterseniz nasıl bir yol izlersiniz? İzlediğiniz bu yola göre sonucu tahmin ediniz?
İlk olarak sayıları en yakın onluğa yuvarlar ve işlemi yaparım.
12 + 6 = 18

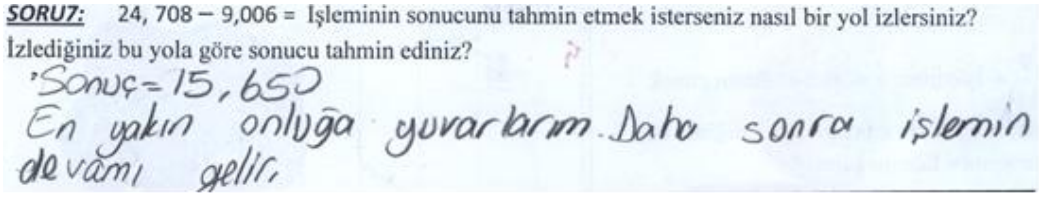
Question 3: If you want to predict the result of this mathematical operation, how do you answer it? Please, predict the answer according to your way of solution.

"Firstly the numbers are rounded the next decimal point and later the operation is done. 12+6=18"


SORU5:
$7,098 \cdot 5,61 = 42$
İşleminin sonucunu tahmin etmek isterseniz nasıl bir yol izlersiniz? İzlediğiniz bu yola göre sonucu tahmin ediniz?
Sayıları yuvarlarım. Sonrada kolayca çarparım.
42

Question 5: If you want to predict the result of this mathematical operation, how do you answer it? Please, predict the answer according to your way of solution.

"I rounded the numbers and later easily multiply them."

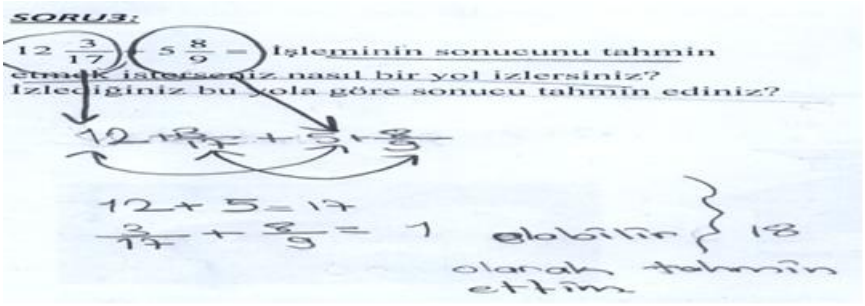


Question 7: If you want to predict the result of this mathematical operation, how do you answer it? Please, predict the answer according to your way of solution.

"Result: 15,600. I rounded the next decimal point. Later the rest of the operation."

Grouping Strategy

If the numbers in the operation are close to another value, the numbers are grouped according to these values and the result is reached with grouping.



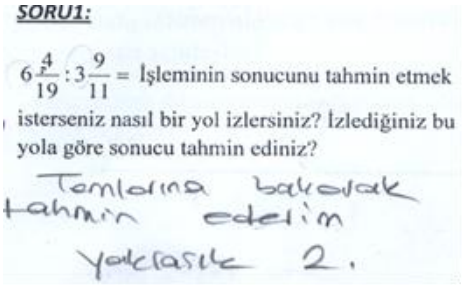
Question 3: If you want to predict the result of this mathematical operation, how do you answer it? Please, predict the answer according to your way of solution.

"12+ 5=17 Fraction operation: Maybe 1. The answer can be 18."

In the above question, students grouped the whole numbers and fractions separately and grouped the values and find the answer after grouping.

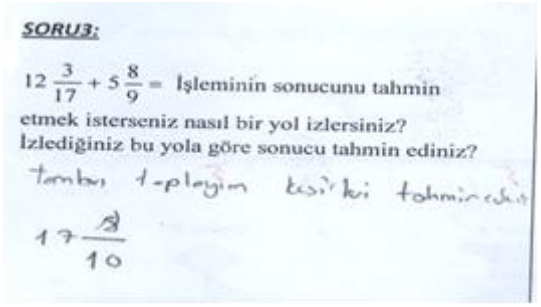
Operation According to First and Last Digits

This strategy includes predicting the answer by adding rightmost and leftmost units. Especially, in decimal numbers it includes adding the whole number and decimal fraction separately and reaching the answer.



Question 1: If you want to predict the result of this mathematical operation, how do you answer it? Please, predict the answer according to your way of solution.

"I predict it by looking their whole numbers. Approximately 2."

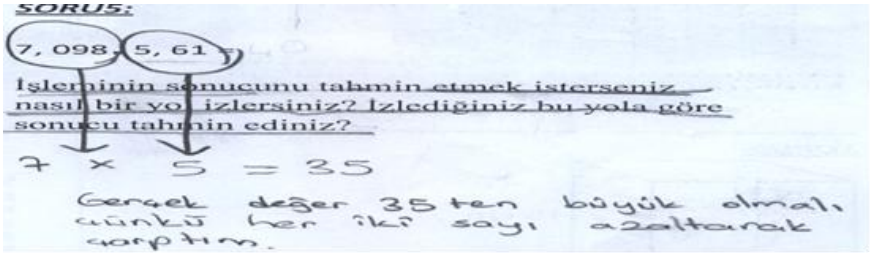


Question 3: If you want to predict the result of this mathematical operation, how do you answer it? Please, predict the answer according to your way of solution.

"I can predict the result by adding the whole numbers."

Revision-Correction Strategy

It is observed that students changed the given numbers and used the more practical ones.



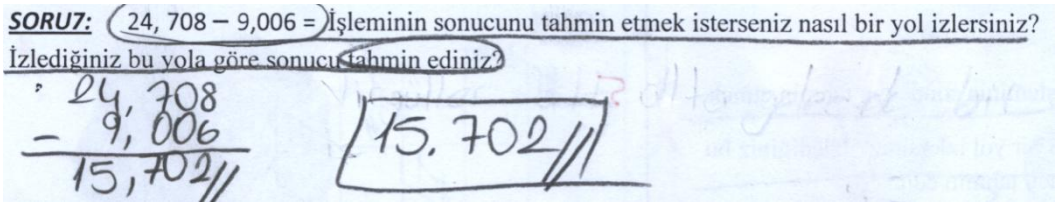
Question 5: If you want to predict the result of this mathematical operation, how do you answer it? Please, predict the answer according to your way of solution.

*"7*5=35 The real value must be more than 35, because I multiplied each number by lessening."*

Instead of the decimal number, the student multiplied the whole numbers and predicted the result based on this operation.

Operation Based on Experience

This strategy includes the way of answering the question "How much" based on personal experiences.

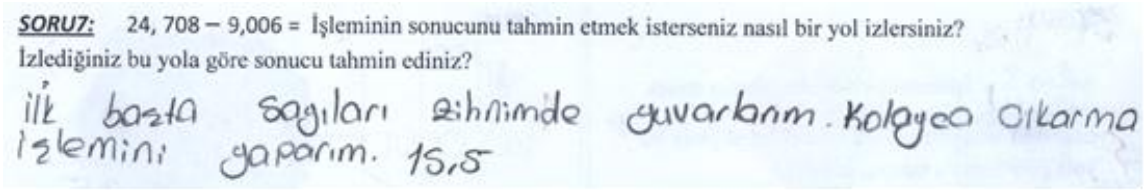


Question 7: If you want to predict the result of this mathematical operation, how do you answer it? Please, predict the answer according to your way of solution.

"15,702"

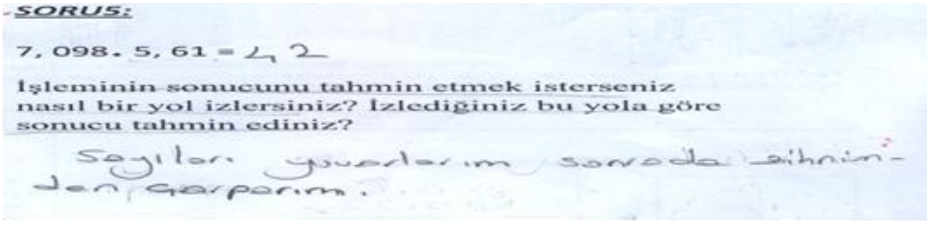
Mental Operation Strategy

Doing the operation like having a paper and pencil in mind, doing each step about the operation in the mind.



Question 7: If you want to predict the result of this mathematical operation, how do you answer it? Please, predict the answer according to your way of solution.

"Firstly I round the numbers in my mind and easily do subtraction."

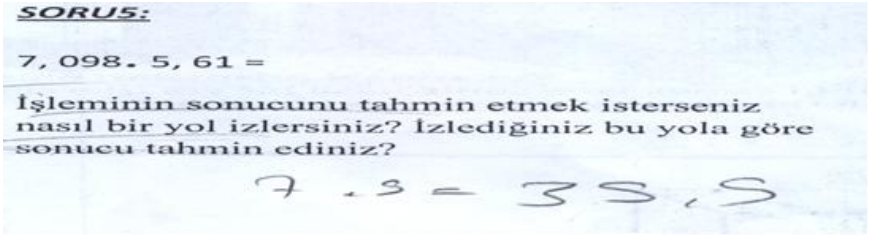


Question 5: If you want to predict the result of this mathematical operation, how do you answer it? Please, predict the answer according to your way of solution.

"I rounded the numbers and multiply them in my mind."

Random Prediction Strategy

In this strategy, the students predict the answer without a rational solution, and answer question with randomly visualized explanations instead of a concrete prediction.

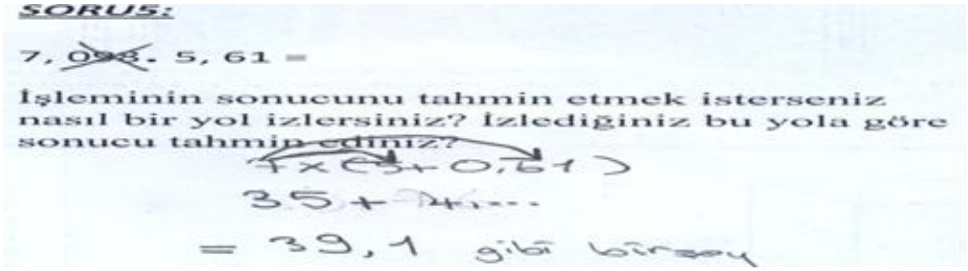


Question 5: If you want to predict the result of this mathematical operation, how do you answer it? Please, predict the answer according to your way of solution.

"7.9=35,5"

Distribution Strategy

It means separating the given numbers for prediction of the result.



Question 5: If you want to predict the result of this mathematical operation, how do you answer it? Please, predict the answer according to your way of solution.

"35 +4,… =Something like 39,1"

Findings With Regards to the Third Sub-Question

The findings about the students' measurable prediction strategies and the numbers and percentages of these strategies were presented in Table 3.

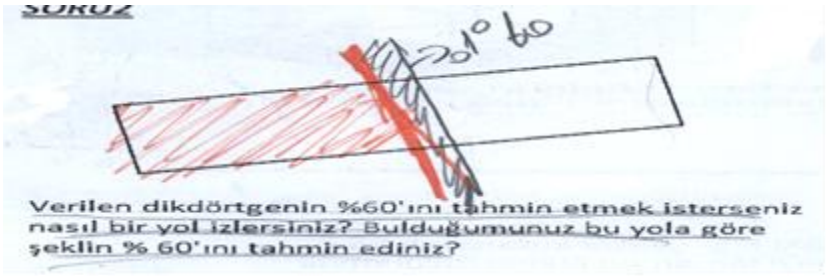
Table 3. Used measurable prediction strategies and their numbers and percentages

Measurable prediction strategies	*n*	*%*
Visualization	85	34,14
Random prediction	62	24,90
Operation based on experience	43	17,27
Inductive	28	11,24
Comparison	22	8,84
Revision-correction	9	3,61
Total	249	100

The students used "Visualization strategy" most (34,14%) and "Revision-correction strategy" less (3,61%). In addition the students used four more measurable prediction strategies in different percentages. The total six strategies were given below with the photographs.

Visualization Strategy

It means visualizing a known measure and using it for the measurement.

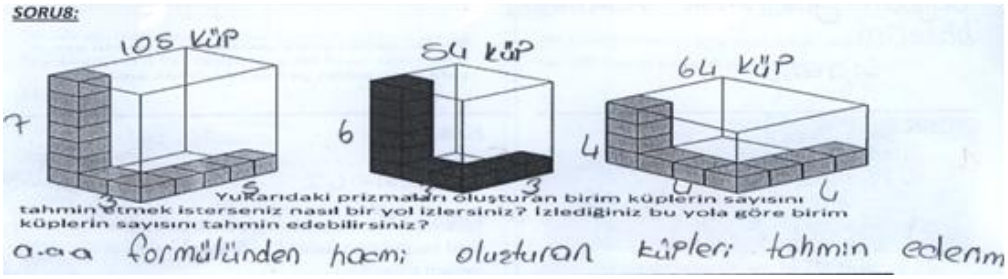


Question 2: If you want to predict 60% of this rectangle, how do you answer it? Please, predict 60% of the figure according to your way of answer.

"60%"

Operation Based on Experience

This strategy includes the way of answering the question "How much" based on personal experiences.

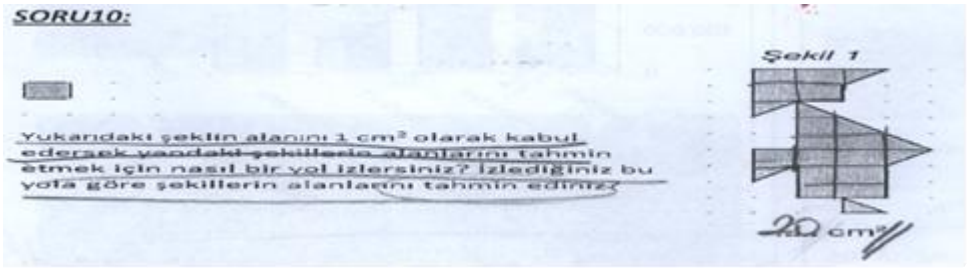


Question 8: If you want to predict the number of unit cubes that unite the above prisms, how do you answer it? Please, predict the number of unit cubes according to your way of answer.

*"From the formula a*a*a , I can predict the cubes of the volume."*

Inductive Strategy

It means separating the problem into sub-sections and reaching the answer from the results of each sub-section.

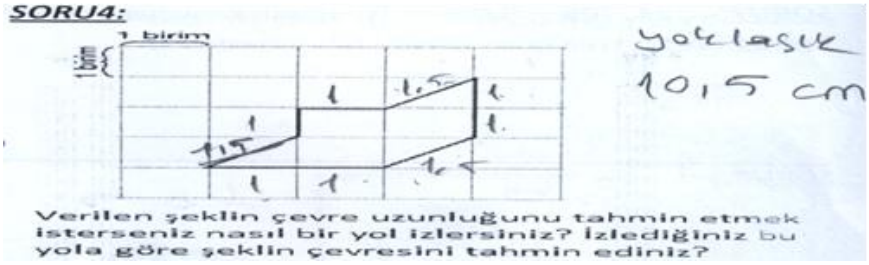


Question 10: If you accept the area of the above figure as 1 cm^2, how do you predict the area of the figures? Please, predict the area of the figures according to your way of prediction.

"20 cm^2"

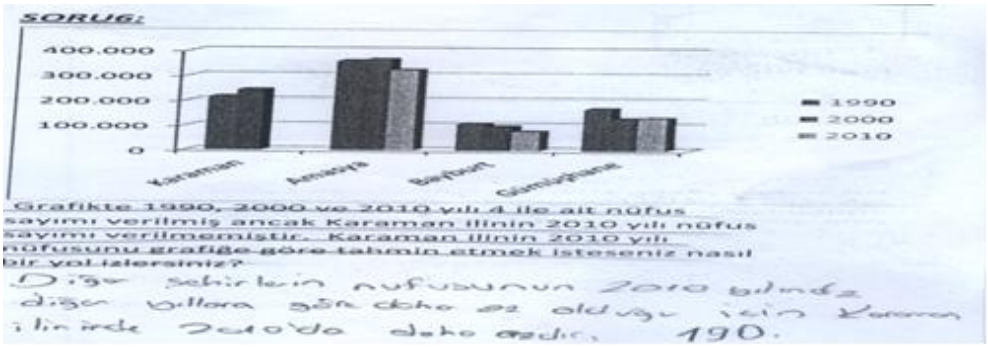
Comparison Strategy

It is the prediction of the result of the real problem from the identifiable starting points.



Question 4: If you want to predict peripheral length of the figure, how do you answer it? Please, predict the peripheral length of the figure according to your way of answer?

"Approximately 10,5 cm."

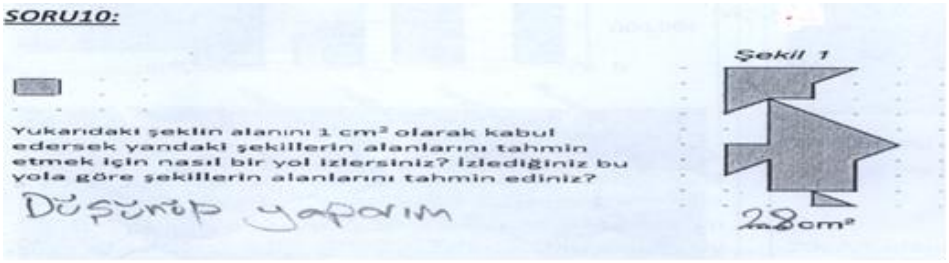


Question 6: Four cities' population numbers in years 1990, 2000 and 2010 are given but the city, Karaman's population number in the year 2010 is not given in the graph. If you want to predict the population of Karaman in 2010 according to the graph, how do you answer it?

"As the numbers of population of other cities in 2010 are less than in other years, Karaman's population is less in 2010, so the answer is 190."

Random Prediction Strategy

This strategy means predicting the answer without a rational solution, and answering it with randomly visualized explanations instead of a concrete prediction.

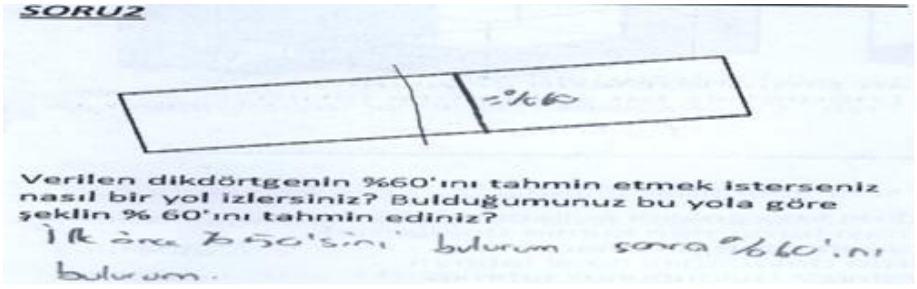


Question 10: If you accept the area of the above figure as 1 cm^2, how do you predict the area of the figures? Please, predict the area of the figures according to your way of prediction.

"I do by thinking."

Revision-Correction Strategy

This strategy means changing the given numbers and using the more practical ones.



Question 2: If you want to predict 60% of this rectangle, how do you answer it? Please, predict 60% of the figure according to your way of answer.

"Firstly, I find 50% of the figure, later I find 60%."

Conclusion, Discussion and Suggestions

In this section, the results reached from the sub-questions were presented and discussions and suggestions were given.

The first sub-question showed that the students prediction strategy use level is less (26,01%). This finding may result from the students' knowledge about these strategies. In addition, this finding may be derived from the students' not doing much prediction problems in their courses. Thought the numbers of operational and measurable prediction questions are equal, the students used measurable prediction strategies (326) more times than measurable prediction strategies (249). This finding may result from the probability of the students' facing measurable strategies more times than the operational ones. In addition, this finding may be derived from the issue of their earlier and frequent facing the measurable problems than the operational ones. The next research about the reasons of students' less strategy use in mathematics can be researched in the future.

The findings of the second sub-question revealed eight operational prediction strategies used by the students. These strategies are operation according to first and last digits, random prediction, operation based on experience, rounding, mental operation, grouping, revision-correction and

distribution. This finding is in parallel with Munakata (2002) and Tekinkır (2008). Another finding of the sub-question is the frequency of the strategy use. The students used operation according to first and last digits 33,74% , random prediction 27,92%, operation based on experience 15,95%, rounding 11,04%, mental operation 7,67%, grouping 1,53%, revision-correction 1,23% and distribution 0,92%. These percentages can say that strategy usage can be grouped under three main headings and much research is need on this issue.

The findings of the third-sub-question revealed the six measurable prediction strategies and they are visualization, random prediction, operation based on experience, inductive, comparison and revision-correction. This finding is similar to the findings of Tekinkır (2008). Percentages of these strategies are as follow: visualization 34,14%, random prediction 24,90%, operation based on experience 17,27%, inductive 11,24%, comparison 8,84% and revision-correction 3,61%. According to the results of Aslan (2011)'s study conducted with fifth grade primary school teachers, the participants have adequate prediction skills, educational programme about these strategies, content and activity numbers, and adequate level of opinions on other issues related to the prediction. The same study also showed that 90,1% of the teachers did not take in-service training about the prediction skills.

Therefore, in-service training for teachers is needed on this issue. In mathematics course programme, separate evaluation forms are needed for the evaluation and measurement of the prediction skills. In addition, extra explanation should be given in the programme for teachers on how to evaluate this skill. Reading activities for the perception and evaluation skills should be emphasised in the course. The environment of the school (e.g. urban) should be considered and appropriate materials should be prepared for teaching. The activities should be prepared by being considered the individual differences and explanative examples should be increased. In addition, the idea of each mathematical question has a unique answer should be abandoned and students should be taught on how to explain the answer within the frame of real value with approximate answers. Students should be encouraged on developing their own strategies in prediction. Then, the prediction problems should be given from daily life issues.

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