Conference Paper

MATDER Journal of Mathematics Education

Vol. 3 No.1 (2018), 19-31

Self-Evaluations of High School Students Regarding Their Own Metacognitive Behaviours in Problem Solving*

Sebiha Kartalcı[1], Handan Demircioğlu[2]

Received: 06.05.2018; **Accepted:** 27.08.2018; **Published**: 15.09.2018

Abstract: The aim of the study is to ensure that high school students evaluate themselves in terms of metacognitive behaviours that they demonstrate during their problem solving process through their experiences of problem solving and to examine this process. The study was designed as a qualitative study and the obtained data were interpreted by descriptive analysis. The working group consists of a total of 94 students in 9th and 10th grade in a high school in a district of Yozgat in the academic year of 2015-2016. To collect data, students were first given two problems. Students are asked to clearly solve these problems and write down what they think. A questionnaire was applied to the students who solved these problems to evaluate the metacognitive behaviours in the problem solving process. When the data obtained from the questionnaire are analyzed, it can be considered that the majority of the students exhibit highly metacognitive behaviours without problem solving. However, the problem solutions of the students do not match these results very much; it is understood that the metacognitive behaviours that the students say they have shown and the metacognitive behaviours that emerged from examining the problem solutions are not generally parallel to each other.

Keywords: Metacognition, self-evaluations, high school students.

INTRODUCTION

The mathematics course in the school has goals such as transfer of mathematical knowledge, associating mathematics with everyday life, to develop a positive attitude towards mathematics, discovering the relationship of mathematics to other fields, to give value of mathematics, problem solving, to be aware of their own reasoning processes in the problem solving process and developing the ability to express these. Schools often give more emphasis to the transfer of knowledge. However, in education, it is more important to know how knowledge is learned and how cognitive

[1] **Corresponding Author:** Sebiha Kartalcı, **e-mail**: sebihakartalci@gmail.com, Math Teacher, MEB Sivas Science and Art Center

[2] Handan Demircioğlu, **e-mail**: handandemircioglu@gmail.com, Asst. Prof, Sivas Cumhuriyet University

* This study was presented as an oral presentation at the International Conference on Mathematics and Education (ICMME-2018) on June 27-29.

Citation: Kartalcı, S., & Demircioğlu, H. (2018). Self-Evaluations of High School Students Regarding Their Own Metacognitive Behaviours in Problem Solving. *MATDER Journal of Mathematics Education, 3(1),* 19-31.

processes progress in learning. In recent years, this issue has also become important. Today, the most distinctive features of good teaching are; how to effectively learn, how to remember (Çakıroğlu, 2007). The key role to teach these skills is "metacognition".

Metacognition means, in the shortest sense, that a person is aware of his own thinking processes and can control these processes (Beauford, 1996; Brown, 1978; Fager, 1979; Hacker and Dunlosky 2003; Huitt, 1997; Jager and Reezigt, 2005; Wellman, 1985; Transporter: Özsoy, 2007). More explicitly, metacognition includes things such as what one knows, how he knows, information about how a job is done, knowledge of which way he will go, which cognitive processes he or she is following when doing a job, self-control, and interpretation of output. This concept was first proposed by Flavell (1971) and continued to develop later. Since metacognition is a difficult concept to explain, it has been investigated by separating the various components (Brown, 1987; Flavell, 1987; Garofalo and Lester, 1985; Livingston, 2003).

In this study, the main components of metacognition are taken as metacognitive knowledge and metacognitive regulation:

1) Metacognitive Knowledge: The world knowledge that an individual gains about cognitive processes and the personal view of the individual's cognitive abilities of himself and others (Akin and Abacı, 2011). This includes declarative knowledge, procedural knowledge and conditional knowledge.

- Declarative Knowledge: It is information about what the person knows about the subject.
- Procedural Knowledge: It is knowledge about how to do the job of the person.
- Conditional Knowledge: It is information about knowing which information the person will use in which case.

2) Metacognitive Regulation: It is the ability to use metacognitive knowledge strategically to reach cognitive goals (Ozsoy 2008). In this study, planning, monitoring and evaluation were taken as sub-components.

- Planning: It contains all the cognitive preparations needed to do a job.
- Monitoring: It is being aware of the work done, continuous to control the work and himself.
- Evaluation: At the end of the work, the degree of achievement of objectives and the gains achieved are interpreted.

Like the definition of metacognition, it is mentioned that its measurement is difficult (Panaoura and Philippou, 2004). Nonetheless, behaviours that could be indicative of the metacognition were determined and worked to make measurements accordingly. When the investigations are examined, it is seen that the metric of the metacognition is sometimes made by considering the first person's own evaluations (Fotunato, Hecht, Title and Alvarez, 1991), and sometimes interpreting interviews, observations and work done by the researcher as an external person (Garofalo and Lester, 1985; Pugalee, 2001). Both methods have advantages and disadvantages. When a person is measured according to their own assessment, the person may not explain what they do not want, they may give different answers because they do not understand the terms in the question, they may tend to give the desired answers because they have anxiety. When the observations and comments of an external researcher are taken as a basis, it is impossible to determine all the operations in the mind of the person since the metacognition is more mental. Some processes may not appear as behaviour when applied in the mind, but may not be reflected to the second person.

21-item questionnaire was developed by Fortunato et al. (1991) for self-assessment of students' metacognitive and cognitive behaviours in the problem-solving process. This questionnaire was tested by applying 7th grade students after non-routine problems were solved. The same questionnaire was used by Biryukov (2004) to solve the perturbation-combination problems and then

to simplify the relationship between metacognitive behaviours and problem solving success of mathematics teacher candidates and field teachers. Again, the same tool was used by Demircioğlu (2008) not to collect data but to allow mathematics teacher candidates to observe the problem-solving processes and give feedback to themselves.

In this study, the questionnaire developed by Fortunato et al. (1991) was used to investigate the self-evaluation of this experience after metacognition students solve the given problems. The aim of the study is to examine the situation arising from high school students' self-evaluations in terms of metacognitive behaviours they exhibit during the problem solving process by examining their problem-solving experiences.

METHOD

The researcher-teacher model was used in qualitative research methods in this study aimed at evaluating themselves in terms of metacognitive behaviours that high school students showed in problem solving process. The researcher-teacher model is the use of the action research model in educational sciences. The action research is aimed at solving the problem in the area and includes the stages of developing a general idea, exploration, planning, evaluation and other action steps (Aksoy, 2003). This study was mostly directed to the "exploration" phase of the action research. Prior to a study aimed at improving the metacognitive behaviours of high school students, it is desired to survey them based on the evaluations of the current state students through this study.

Study Group

The study group constitutes a total of 94 students in 9th and 10th grade in a high school located in Akdağmadeni province of Yozgat province in the first period of 2015-2016 education year. Two class (20 and 22 students) in the 9th grade and two class (27 and 25 students) in the 10th grade participated. The reason why the working group is selected this way is that the researcher is the mathematics teacher of these classes. The data of a randomly selected student (total 4 students) from each class were examined in more detail. Nicknames are used for these students. Aylin and Büşra are 9th grade students, Can and Doruk are 10th grade students.

Implementation and Collection of the Data

For the data collection tool used in this study, two problems were selected for the 9th and 10th grades related to the subjects that students were working during the semester (Ministry of National Education [Mne], 2015; Sahin, 2015). These problems are given in Table 1 with the class level they are using and their related topics.

Table 1: Problems in the Data Collection Tool

Grade	Topic	Problem
9	Sets	In a questionnaire conducted between a certain number of movie audiences, 196 of the audiences said "I like drams", 153 is "I love comedy", 88 is "I love science fiction", 59 is "drama and I liked comedy, 37 liked drama and science fiction, 32 liked comedy and science fiction, and 21 liked three movies. How many people have participated in the survey?
	Absolute Valuable Inequalities	Ahmet says Murat's age is probably 28. Murat also says that he made a correct prediction of Ahmet with a two-year error margin. Murat's real age is x. Accordingly, show the range of Murat's real age inequality.
10	Numeration	The restaurant "Korsikalı" offers the following options. Start: Soup or salad Main course: chicken breast, beef steak, fish Dessert: Pudding or cake How many different orders can be made at this restaurant?
	Probability	There are 3 black and 2 white balls in the black bag. There are 4 black and 3 white balls in the white bag. From a randomly selected bag, what is the probability that a ball shot randomly from bags is in the same color as the bag?

The questionnaire "How Do I Solve the Problems?" developed by Fortunato et al. in 1991 was used to evaluate students' metacognitive behaviours in the process of problem solving by overseeing problem solving processes. This questionnaire consists of 21 items and 4 parts. There are items related to the plans made before solving the problem in the first part, about what is done in the problem solving process in the second part, related to the control processes after solving the problem solving in the third part and related to strategies used in problem solving in the last part.

In each class the application was carried out in the same way. First, the data collection tool with the two problems given in Table 1 is distributed. Students are asked to clearly solve these problems and write down what they think. Two problems were made in about 30 minutes. Later, these papers were collected and a questionnaire was given to evaluate the process and students were asked to complete the questionnaire considering the problem-solving experience they had just experienced. These papers were collected after the survey was completed. The whole application lasted approximately 1 lesson (40 minutes).

Analysis of Data

For the analysis of the data, frequency analysis and descriptive analysis were generally performed. First of all, the responses of the 94 students to the questionnaire were all collected on a table and the frequencies and percentages of the answers given for each item were calculated. Then problem solving processes of students are examined and problem solving processes are described and interpreted together with the survey results. In doing so, problem solutions and questionnaire responses were obtained for 4 randomly selected students, one from each class.

FINDINGS

In this section, first of all, the questionnaire data is presented. The results obtained from the 94 students who participated in the survey are summarized in Table 2 as frequency and percentage. Table 2 gives the data for the entire study group with 9th and 10th grade levels.

Table 2. Group Findings of How to Solve Problems Questionnaire

		Yes				No				Maybe			
		9	**10**	**Tot.**	**%**	**9**	**10**	**Tot.**	**%**	**9**	**10**	**Tot.**	**%**
What did you do before you started to solve the problem?													
1	I've read the problem more than once.	33	36	**69**	**73,4**	4	9	**13**	**13,8**	5	7	**12**	**12,8**
2	"Do I understand what is being asked in the problem?" I asked myself.	18	30	**48**	**51,1**	10	11	**21**	**22,3**	13	11	**24**	**25,5**
3	I tried to express the problem with my own words.	28	38	**66**	**70,2**	6	8	**14**	**14,9**	8	5	**13**	**13,8**
4	I tried to remember that I solved a similar problem before.	26	33	**69**	**73,4**	10	2	**12**	**12,8**	6	7	**13**	**13,8**
5	I thought about what the information I need to solve this problem is	26	31	**57**	**60,6**	4	8	**12**	**12,8**	11	12	**23**	**24,5**
6	"Is there any information I do not need in this problem?" I asked myself.	14	14	**28**	**29,8**	17	25	**42**	**44,7**	11	13	**24**	**25,5**
What Have You Done When Solving the Problem?													
7	I thought about all the steps when solving the problem.	24	26	**50**	**53,2**	2	10	**12**	**12,8**	16	16	**32**	**34,0**
8	After taking a step, I looked at what you were doing backwards.	29	25	**54**	**57,4**	6	16	**22**	**23,4**	6	12	**18**	**19,1**
9	After finishing a step I stopped and thought again	32	28	**60**	**63,8**	5	17	**22**	**23,4**	5	6	**11**	**11,7**
10	When I solved the problem, I checked my work step by step.	24	27	**51**	**54,3**	5	10	**15**	**16,0**	13	14	**27**	**28,7**
11	I did my step again when I did something wrong.	26	25	**51**	**54,3**	7	14	**21**	**22,3**	9	14	**22**	**23,4**
What did you do after finishing the Problem Solving?													
12	I looked back to see if I did the right things.	32	36	**68**	**72,3**	3	9	**12**	**12,8**	7	7	**14**	**14,9**
13	I checked whether I did my calculations correctly.	34	38	**72**	**76,6**	1	4	**5**	**5,3**	7	10	**17**	**18,1**
14	I went back and checked my work again	28	33	**61**	**64,9**	4	12	**16**	**17,0**	10	7	**17**	**18,1**
15	I look at the probing again to see if my answer means anything.	30	31	**61**	**64,9**	6	10	**16**	**17,0**	6	11	**17**	**18,1**
16	I thought about a different way to solve the problem.	21	25	**46**	**48,9**	12	18	**30**	**31,9**	9	9	**18**	**19,1**
Have you used any of these routes while solving the problem?													
17	I have drawn a shape to help me understand the problem.	26	20	**46**	**48,9**	8	29	**37**	**39,4**	8	3	**11**	**11,7**
18	I used the "guess and control" method.	34	37	**71**	**75,5**	3	7	**10**	**10,6**	5	8	**13**	**13,8**
19	I selected the process I needed to solve this problem.	26	39	**65**	**69,1**	1	5	**6**	**6,4**	15	8	**23**	**24,5**
20	I have been feeling confused and I can not decide what to do.	13	18	**31**	**33,0**	13	21	**34**	**36,2**	16	13	**29**	**30,8**
21	I have noted important information.	12	9	**21**	**22,3**	24	36	**60**	**63,8**	6	7	**13**	**13,8**

When the survey data is examined, it is mostly answered as "yes", so it can be considered that students have a high level of metacognitive behaviours during problem solving.

In the first part (planning), it is seen that the majority of all the items out of the article "Is there any information I do not need in this problem? I asked myself." (6) respond positively. In the second

part (monitoring), it is seen that students mostly responded to all the items (7-11) positively. In the third part (evaluation), it appears that the majority of students outside the item " I thought about a different way to solve the problem." (16) respond positively. In the last part (strategies), it seems that most of the students responded negatively or vaguely to the items (17, 20, 21) "I have drawn a shape to help me understand the problem", "I have been feeling confused and I can not decide what to do" and "I have noted important information". It is seen that students mostly respond positively to " I used the guess and control method." and "I selected the process I needed to solve this problem." (18, 19).

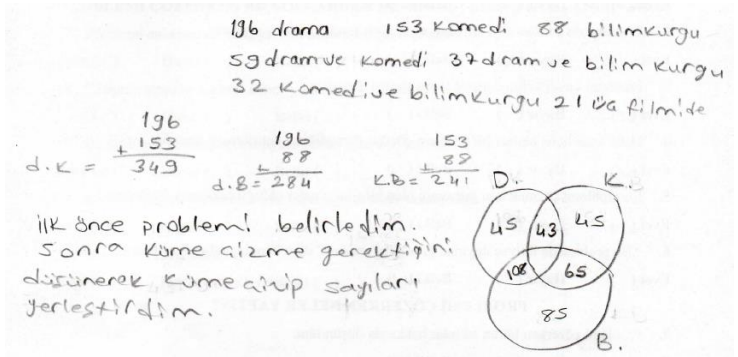
Although the data in the questionnaire are more related to the internal processes and it is not possible to check the truth directly from the problem solutions, it has wanted to compare the survey data and problem solutions. For this, the papers of 4 students, one from each branch, were randomly selected and examined. Table 3 shows the responses of these students to the items of the questionnaire using initials.

Table 3. Answers to the How to Solve Problems Questionnaire

	Yes	No	Maybe
What did you do before you started to solve the problem?			
1. I've read the problem more than once.	A-B-D	C	
2. "Do I understand what is being asked in the problem?" I asked myself.	B-C-D	A	
3. I tried to express the problem with my own words.	A-B-C-D		
4. I tried to remember that I solved a similar problem before.	A-B-C-D		
5. I thought about what the information I need to solve this problem is.	B-C-D	A	
6. "Is there any information I do not need in this problem?" I asked myself.	C-D	A-B	
What Have You Done When Solving the Problem?			
7. I thought about all the steps when solving the problem.	B	C	A-D
8. After taking a step, I looked at what you were doing backwards.	A-B-D	C	
9. After finishing a step I stopped and thought again.	A-B	C-D	
10. When I solved the problem, I checked my work step by step.	B-D	C	A
11. I did my step again when I did something wrong.	A-B-D	C	
What did you do after finishing the Problem Solving?			
12. I looked back to see if I did the right things.	A-B-D	C	
13. I checked whether I did my calculations correctly.	A-B-C-D		
14. I went back and checked my work again.	A-B-D	C	
15. I look at the probing again to see if my answer means anything.	B-D	C	A
16. I thought about a different way to solve the problem.	C	B-D	A
Have you used any of these routes while solving the problem?			
17. I have drawn a shape to help me understand the problem.	A-B	C-D	
18. I used the "guess and control" method.	A-B-C-D		
19. I selected the process I needed to solve this problem.	A-B-C-D		
20. I have been feeling confused and I can not decide what to do.	A-B	C-D	
21. I have noted important information.	B-D	A-C	

As seen in Table 3, students often tend to respond "yes" to the items in the survey. Only Can has given more "no" answers. In order to compare the students' survey findings with the problem solutions, the problem solutions of these 4 students were examined. The original solutions of students and the English of their written explanations were given together.

Figure 1: The Solution of Aylin's First Problem

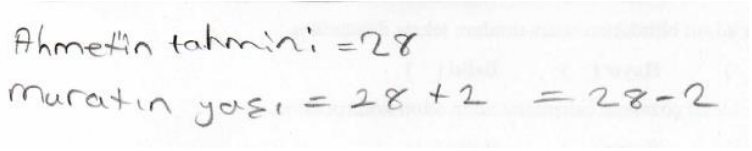


196 drams 153 comedy 88 science fiction. 59 drams and comedy, 37 drams and science fiction, 32 comedy and science fiction, 21 all three-movies.

First I identified the problem. Then thought that I had to draw a set and I set up the numbers.

Aylin first noted the important information given in the problem (planning). Then she sums up the element numbers of the three sets as two given in the problem. It is not known why she did this. She might have tried to solve similar problems about union of sets thinking (procedural knowledge). But she did not go on this path and did not reach a conclusion. She then showed the sets by way of a scheme (planning), but did not make an explanation as to how she placed the numbers placed in the sets. She finally tried to explain what he did (monitoring). She has not found a solution to the problem.

Figure 2: The Solution of Aylin's Second Problem



Ahmet's estimate= 28

Age of Murat= 28+2=28-2

In the second problem, Aylin noted the basic knowledge given first (planning). Since she had interpreted the expression "2 years error margin" in the problem as 2 years more or 2 years less, she wrote two results as 28 + 2 and 28-2 for Murat's age. In fact, she has taken the right approach, but she has only taken the extreme points of the error share, not the interval. In this problem, Aylin did not explain.

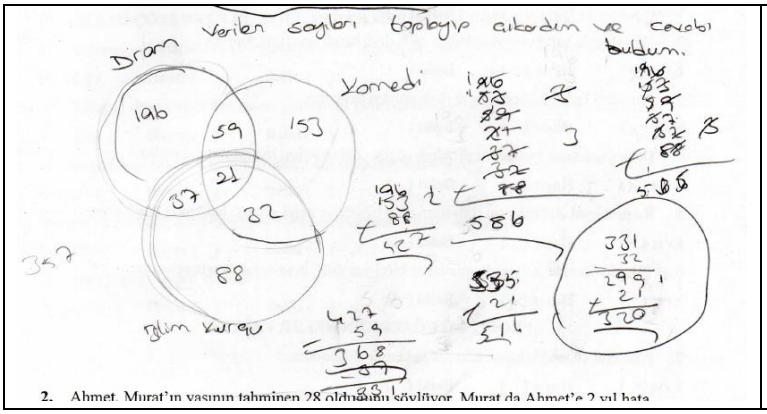
Aylin seems to have read the two problems underlined, especially for important information. She may have read the problem more than once (1). She wrote information on the problem at the beginning. This may be the way to express her problem with her own words (3). Particularly in the first problem, it is seen that she tried the methods which are similar to the methods that are used at the lesson (4). In the second part of the questionnaire, the answers to the questions about self-monitoring were generally positive. Although this case can not be observed much in her solutions, it can be detected by in the first problem he tries to do it by drawing a schematic at first, not to go out of his way, and finally trying to explain how he thinks in the process. There are no errors in the calculations that she made. This can be a sign that she come back what she does at the end (12, 13, 14). In the first question, she drew the sets in a scheme (17). Although she did say that she used the method of guess and control in the questionnaire, this method has not been seen in her solutions. In the first problem, it is understood that her head has been confused because he can not fully determine the path he will follow and can not reach the result (20). Aylin responded "no" to items 2,

5, 6 and 21 in the survey. The answer, which does not note important information in item 21 between these items, does not correspond to his solutions. Because the important numerical information given in both problems is noted at the beginning.

In the second problem, Aylin noted the basic knowledge given first (planning). Since she had interpreted the expression "2 years error margin" in the problem as 2 years more or 2 years less, she wrote two results as 28 + 2 and 28-2 for Murat's age. In fact, she has taken the right approach, but she has only taken the extreme points of the error share, not the interval. In this problem, Aylin did not explain.

Aylin seems to have read the two problems underlined, especially for important information. She may have read the problem more than once (1). She wrote information on the problem at the beginning. This may be the way to express her problem with her own words (3). Particularly in the first problem, it is seen that she tried the methods which are similar to the methods that are used at the lesson (4). In the second part of the questionnaire, the answers to the questions about self-monitoring were generally positive. Although this case can not be observed much in her solutions, it can be detected by in the first problem he tries to do it by drawing a schematic at first, not to go out of his way, and finally trying to explain how he thinks in the process. There are no errors in the calculations that she made. This can be a sign that she come back what she does at the end (12, 13, 14). In the first question, she drew the sets in a scheme (17). Although she did say that she used the method of guess and control in the questionnaire, this method has not been seen in her solutions. In the first problem, it is understood that her head has been confused because he can not fully determine the path he will follow and can not reach the result (20). Aylin responded "no" to items 2, 5, 6 and 21 in the survey. The answer, which does not note important information in item 21 between these items, does not correspond to his solutions. Because the important numerical information given in both problems is noted at the beginning.

Figure 3: The Solution of Büşra's First Problem

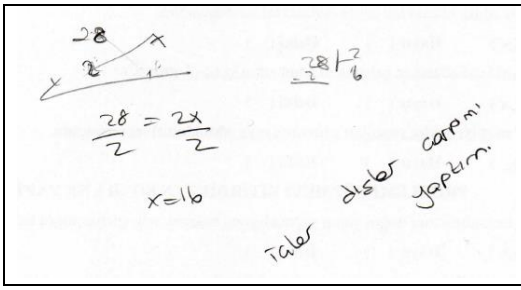


I added up and subtracted the numbers given, and I found the answer.

Büşra first laid out the scheme of the sets given in the problem (planning). Then he placed the numbers given in the problem on this scheme. However, while she was doing the placement, she made a mistake either because she did not analyze the information given in the problem well, or because she could not learn how to solve these problems very well. For example, she thought the number of drama lovers in the problem is "the number of only drama lovers" and the number of drama and comedy lovers in the problem as "the number of drama and comedy lovers who do not like science fiction." On the other hand, she firstly added all numbers given in the problem. Since she may have thought that she could not reach a result here, this time he started by adding the element numbers of the three main sets given in the problem. Processes which she has made here show that

while she was finding the union's number of elements of the three sets, she followed the correct steps. However, she found the right result to be less than 10 because she made a small process error in the first addition.

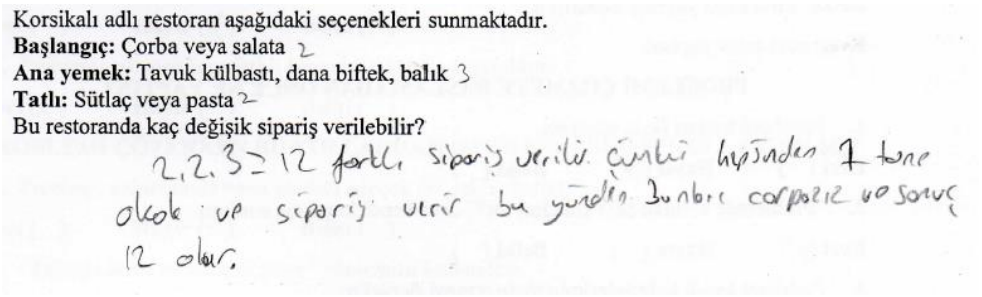
Figure 4: The Solution of Büşra's Second Problem

	*I did cross-multiplication.*

Büşra approached to second problem from a wrong way. This can be understood from that while the problem was related to the issue of "inequality", she was trying to solve by establishing ratios and equations. Büşra might have acted that way because she did not understand the problem or could not find a suitable solution. She has made a mistake in this wrong path that she has already gone. She wrote that she was benefiting from cross-multiplication (procedural knowledge).

Büşra underlined the two problems by highlighting important information. She may have read more than one (1). Büşra stated that she tried to express the problem with his own words in the questionnaire. However, there was no such written expression in her solutions. In the first problem, it is understood that she tried to remember that she had solved a similar problem earlier and thought about the information she needed (4, 5). In the second part of the questionnaire, Büşra gave positive responses to all of the items related to self-monitoring, which were made while solving the problem. This situation is not reflected in the solutions because she does not write much explanation. But that does not mean that Büşra does not exhibit the behaviour in the second part. Self-evaluation items in the third part of the questionnaire were generally answered as "yes". Although Büşra has stated that she controls her calculations in this section, it seems that there is a calculation error in both questions. Büşra may not have checked it, or she may have not noticed the error when she checked it. Although Büşra claims that probing looks again to see if the answer is meaningful, in the second problem, her attempt to find a definite value indicates that there is no meaning between the problem and the solution. In the first problem, she used the figure-drawing strategy (17). Although she stated that he used the method of guess and control on the questionnaire, it has not seen this method in her solutions. In the first problem, it is understood that her head is mixed (20). Because she tried to use different methods and tried to make an irrelevant solution to the second problem. Büşra stated that she notes important information in the survey. Despite this, she did not find notes on her paper. Büşra responded "no" to items 6 and 16 only. Although she said that she did not think about a different way to solve the problem in the number 16, it seems that she changed the method in the solution of the first problem.

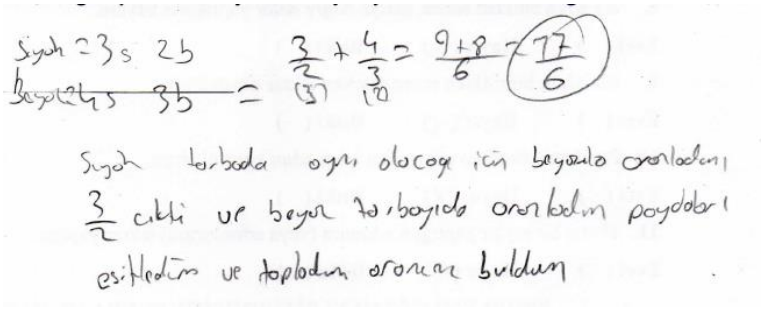
Figure 5: The Solution of Can's First Problem


Korsikalı adlı restoran aşağıdaki seçenekleri sunmaktadır.
Başlangıç: Çorba veya salata 2
Ana yemek: Tavuk külbastı, dana biftek, balık 3
Tatlı: Sütlaç veya pasta 2
Bu restoranda kaç değişik sipariş verilebilir?
2.2.3=12 farklı sipariş verilir çünkü başından 1 tane olcak ve sipariş verir bu yüzden 3 sayıyı carpıcaz ve sonuç 12 olur.

2.2.3=12 different orders are given. Because there will be one from each one and he gives order. So we multiply them and the result is 12.

It appears that Can has written the numbers of the meals alongside the information to summarize the information given in the first problem (procedural knowledge, planning). He multiplied these numbers and reached the right result. It is understood from his explanations that Can knew that one must be careful about the point of choosing one from each type of food and process to be done in such cases where a progressive selection is required.

Figure 6: The Solution of Can's Second Problem


Siyah = 3s 2b
Beyaz 4s 3b
3/2 + 4/3 = 9+8/6 = 17/6
Siyah torbada aynı olacağı için beyazla oranladım 3/2 çıktı ve beyaz torbayıda oranladım paydaları eşitledim ve toplayıp oranlar buldum

Black= 3b 2w

White= 4b 3w

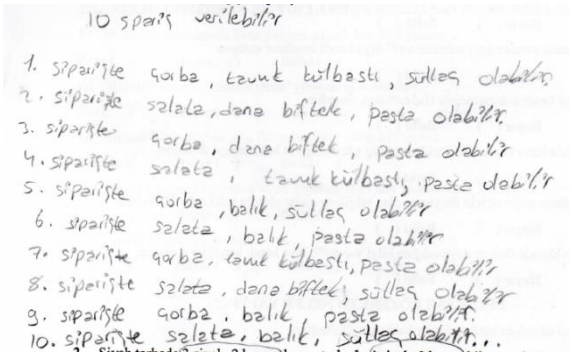
Because the black bag is the same, I rate it with white. It was 3/2 and I also rated the white bag. I equalized the denominations, I added them up, I found the ratio.

Firstly Can summarized the information given in the question on the second problem (procedural knowledge, planning). By the time the solution, Can has taken the ratios of the number of black balls in each of the bags to the number of white balls and he added these ratios wrongly. He has also expressed the process he has done (monitoring). It may be thought that he does not understand the question of probability or the logic of such probabilities question about why he chooses such a solution.

Unlike the group, Can responded "yes" to 9 of the items in the survey and "no" to 12 of them. Since Can summarizes the information given in the problem, it can be considered that he tried to express the problem with his own words (3). Can's follow-up at the solution of the first problem may show that she thought about similar problems before (4). Can replied "no" to all of the items related to self-monitoring in the second part of the questionnaire (7-11). He did not reflect the behaviours mentioned in this section in his solutions. It can be considered that Can's solution checks whether he

has made his calculations correctly since he did not encounter a transaction error (13). Although he states that he uses the "guess and control" method, this has not seen in his solutions. However, this does not mean that he is not using it anyway. He answered "no" in items 1, 12, 14, 15, 17, 20 and 21 except the second part of the questionnaire. When solving the problems Can did not draw any shape as mentioned before (17). He stated that he did not record important information. However, it appears that the problem solutions are noted as a summary of the information given at the beginning.

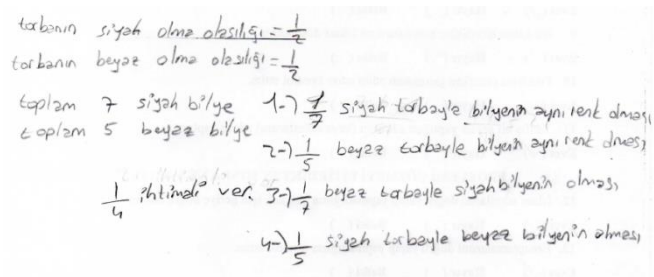
Figure 7: The Solution of Doruk's First Problem



10 orders can be placed.
In the 1st order soup, chicken breast, pudding can be.
In the 2nd order salad, beef steak, cake can be.
In the 3rd order soup, beef steak, cake can be.
In the 4th order salad, chicken breast, cake can be.
In the 5th order soup, fish, pudding can be.
In the 6th order salad, fish, cake can be.
In the 7th order soup, chicken breast, cake can be.
In the 8th order salad, beef steak, pudding can be.
In the 9th order soup, fish, cake can be.
In the 10th order salad, fish, pudding can be.

It seems that Doruk tried to solve the problem by listing the possible cases in the first problem. While listing, most cases have been written, but 2 cases have not been written because they may not have come to mind. It may be because the reason Doruk can not write all possible situations is that he does not go through a certain matching sequence.

Figure 8: The Solution of Doruk's Second Problem



The possibility of the bag being black = 1/2
The possibility of the bag being black = ½

Total 7 black ball, 5 white ball.

1) 1/7 the same color as the black bag and the ball.
2) 1/5 the same color as the white bag and the ball.
3) 1/7 the white bag and the black ball.
4) 1/5 the black bag and the white ball.

There's a 1/4 possibility.

In the second problem, Doruk correctly wrote the probabilities of selecting the bags. It is clear that Doruk first thought that bag selection should be made (procedural information). However, afterwards, he determined the numbers of the total black and yellow balls in the bags and made the selection situations on them. In fact, he was able to think and express all the situations (4 situations) that could be related to the bags and balls to be selected. He has made the wrong turn and has not reached the right conclusion.

It seems that Doruk read two problems carefully. Because he rounded and underlined important information. From here it can be thought that he may have read more than one to understand the problem (1). Even though he stated that he was trying to express himself with his own words, no such attempt was made in his solutions. Though he stated that he controlled his work step by step while solving the problem, it seems that some cases have been overlooked. Doruk

responded to the majority of the items in the third part of the questionnaire with "yes". There are no reflections about this in his solution. He says that he used the "guess and control" method when solving problems, but it is not seen in their solutions. He said that he notes important information, but such notes were not found on his paper. It is seen that Doruk responded "no" to items 9, 16, 17 and 20. He did not figure in solving the problems (17).

DISCUSSION AND CONCLUSION

When the results of the questionnaire are examined, the following can be said:

- In the planning part of the problem solving process, it is seen that students mostly responded "yes" to the items. From here it can be said that most of the students have already thought about the operations that they have to do, they are trying to benefit from their previous experiences and they are trying to understand the problem and the desire first. In this section, it is seen that only a minority of those who responded "yes" to the question “Is there any information I do not need in this problem, I asked myself.” It can be considered here that students often have the belief that all given use should be used or that they can not distinguish what is given in the problem as necessary-unnecessary.
- In the process of problem solving, it was seen that the majority of the students gave the answer "yes" to the items. It can be said that the majority of the students are aware of what they are doing during problem solving, knowing what they are doing, checking the steps they are taking. However, although the majority of respondents gave the answer "yes", the rates were lower than in the previous section.
- The part of after solving the problem, students often responded "yes" to items at high rates. From this it can be said that the majority of the students think about the things which they do after solving the problems, that they control their estimates. In this section, it was seen that the ratio of those who answered "yes" to "I thought about a different way to solve the problem" was found to be low. It can be assumed from this that students often have the belief that the problems can be solved in one way or that they have the conclusion that the important thing is to conclude the problem and then there is not a need to try other ways.
- In the strategies used when solving the problem, students responded to "yes" at high rates to items which are related to using the method of “guess and control” and selecting the processes needed, while the rate of "yes" response to other items is low. It can be said that there are not many students who use the drawing strategy and students who distinguish important notes. Again, in this section, it was seen that the most "no" response was given to the article " I have been feeling confused and I can not decide what to do.". As a result, it can be assumed that the students are not very aware of the strategies they use.
- Generally, there is no significant difference between class levels.
- When the whole questionnaire is commented on, it can be considered that the majority of the students actually have higher metacognitive behaviours in problem solving. Normally, the level of metacognitive behaviour predicts success, but in this study while the level of metacognitive behaviour in the applied questionnaire is high, the problem solving success is low. However, when we compare the answers of the questionnaire and solutions of problems for 4 students, it seems that they do not quite match the results obtained from this table. In other words, metacognitive behaviours that students say they have shown and metacognitive behaviours that arise from examining problem solutions are not always parallel to each other. In addition, fewer metacognitive behaviours could be detected in problem solving of students. However, it should

be kept in mind that students do not write much about what they think when solving problems. Because the metacognition is an intrinsic process, it can be interpreted as much as the person transfers to the other side. When the transmission is low, it may not always be right to think that there is little or no metacognitive behaviour.

- In general, it has been observed that the students in the questionnaire responded “yes” to the majority of items. it seems that those who gave "no" or "maybe" answers in the items 6, 16, 17, 20 and 21 are more than those who gave "yes". This result is consistent with the results obtained by Fortunato et al. (1991). In their study, they also found that items 6, 16, 17, 18, 20 and 21 were generally answered "no". Unlike other studies, in this study the majority of students responded positively to item 18.

Suggestions for teachers and researchers can be given as a result of this study. In future studies, it will be useful to use different methods and techniques such as vocal thinking and interviewing instead of collecting data from written papers only if students want to reach self-assessment on metacognition. Rather than teaching teachers the shortest path to problem solving and teaching them to solve it automatically, teachers should give their students an opportunity to think about improving their metacognitive behaviours and to find out what their students are doing and find their way.

REFERENCES

Akın, A. and Abacı, R. (2011). *Metacognition*. Ankara: Nobel Publishing.

Aksoy, N. (2003). Action research: a method to be used to improve and change educational practices. *Journal of Theory and Practice in Education Management*, *9*(4), 474-489.

Biryukov, P.(2004). Metacognitive aspects of solving combinatorics problems. *International Journal for Mathematics Teaching and Learning* (01.07.2006) www.cimt.plymouth.ac.uk/journal/biryukov.pdf

Brown, A. L. (1978). Knowing when, where, and how to remember; a problem of metacognition. *Advances in Instructional Psychology*, *1*.

Brown, A. (1987). Metacognition, executive control, self-regulation, and other more mysterious mechanisms. *Metacognition, motivation, and understanding*, chapter 3, 65-116.

Çakıroğlu, A. (2007). Metacognition. *Turkey Social Research Journal,* 11 (2), 21-27.

Demircioğlu, H. (2008). *The influence of the educational situations designed for the development of metacognitive behavior of mathematics teacher candidates* (Doctoral Thesis). Gazi University, Ankara.

Doğan, A. (2013). Metacognition and metacognitive teaching. *Middle Eastern & African Journal of Educational Research*, (3), 6-20.

Flavell, J.H.(1979). Metacognition and cognitive monitoring. *American Psychologist,* 34 (10) 906-911, October 1979.

Fortunato, I, Hecht, D., Title, C. K and Alvarez, L. (1991). Metacognition and problem solving. *The Arithmetic Teacher,* Dec. 39(4) 38.

Garafalo J. and Lester, F. (1985) *Metacognition, cognitive monitoring and mathematical performance.* Journal for Research in Mathematics Education, 16, 163–175.

Livingston, J. A. (2003). Metacognition: An Overview. https://files.eric.ed.gov/fulltext/ED474273.pdf (15.04.2018)

Ministry of National Education (Mne) Commission (2015). *Secondary Mathematics Class 9 1st Book*, Mne Publications, Ankara. S.108, 198.

Özsoy, G. (2008). Metacognition. *Turkish Journal of Educational Sciences,* 6(4), 713-740.

Panaoura, A. and Philippou, G. (2005). The measurement of young pupils’ metacognitive ability in mathematics: The case of self-representation and self-evaluation. In *Proceedings of CERME* (Vol. 4).

Pugalee, D. K. (2001). Writing, mathematics, and metacognition: Looking for connections through students' work in mathematical problem solving. *School Science and Mathematics*, *101*(5), 236-245.

Şahin, M. (2015). *Mathematics 10*. Ankara: Palme Publishing, S.10, 97.