European Journal of Education Studies
ISSN: 2501 - 1111
ISSN-L: 2501 - 1111
Available on-line at: www.oapub.org/edu

doi: 10.5281/zenodo.438145

Volume 3 | Issue 4 | 2017

THE EFFECTS OF MATHEMATICAL DISCUSSION ENVIRONMENT SUPPORTED BY METACOGNITIVE PROBLEMS ON THE PROBLEM POSING SKILLS OF 3TH GRADE PRIMARY SCHOOL GRADE STUDENTS[i]

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Abstract:
The aim of this research is to examine the effects of mathematical discussion envıronment supported by metacognitive problems on the problem posing skills of grade 3th primary school grade students. The study was carried out based on pre-test and post-test, control group model. Two experiment and one control group were formed from the students who participated in the research. The sample group consists of 52 students who are studying at the third grade level. According to the findings obtained from the research, it is seen that the discussion method supported by metacognitive questions applied in experiment-1 group, is especially effective in the dimensions of problem posing as "Realization of the Components of the Problem (RCP)", "Identification of the relationship between concept and operation (IRCC)", "Establishment of the problem requiring desired operation (EPRDO)" and "Posing problems based on the given visual and numerical data (PPGVN)".

Keywords: metacognition, discussion, problem-solving, primary grades

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1. Introductıon

When we examine today's approaches to mathematics education, it is seen that mathematics education is considered not only to be something belongs to expert mathematicians but also as a discipline that aims to educate people who apply knowledge, do mathematics, and solve problems (Gür and Korkmaz, 2003). In this respect, each student is considered to be an essential part of their education to discover and produce their own mathematical problems (Kilpatrick, 1987). In this sense, the problem-posing ability becomes as important as problem solving skills. Posing problems in the literature is defined as an important component of the mathematical development of learners, and it is indicated that learning is an intrinsic activity (NCTM, 1991; Silver, 1994). Creating a problem involves actually asking questions to be examined or discovered about a given situation, and creating new problems. At the same time, a strong relationship between problem solving and probe posing is implied in the literature, and this relationship is expressed as “Those who can pose a problem, can also solve it” (Polya, 1957).

It is possible to classify problem posing situations as free, semi-structured or structured (Stoyanova and Ellerton, 1996). Free problem setting situations are the cases where the students are asked to produce a problem from an artificial or natural situation. No specific problem is given in establishing free problems, students are asked to create problems depending on a natural situation (Stoyanova, 2003). Semi-structured problem-solving situations are the cases in which the students use their knowledge, skills and concepts and the patterns they have learned from their previous mathematical experiences when the students are given an open ended case and to explore the structure of this case. Semi-structured situations are the problems such as open-ended problems, similar problems with given problems, similar problems with similar solutions, problems related with special theorems, problems created from given pictures and verbal problems (Abu-Elwan, 1999). Students will be given a well-structured problem or problem case and will be asked to pose a problem which is compatible with the given problem or solution in the structured problem posing situations.

Mathematics education, in addition to those mentioned above, is aiming at providing individuals with the basic knowledge about subject areas, as well as guiding thinking; being consistent in the conclusions reached by their reasoning (Yildirim, 2000). This includes high-level mental activities such as mathematical reasoning, setting strategy, being aware of cognitive processes (NCTM, 2000).

In the literature, the metacognition is defined as the process in which an individual is being aware of his/her mental activities in the perception, recollection and thinking and hence controlling them (Huitt, 1997, Hacker and Dunlosky, 2003). Flavell

(1976) has shown that metacognitive skills are the most important factors explaining the success of solving problems. It has been observed that there is a significant relationship between problem solving skills and metacognitive skills; teaching of these skills has increased the success of solving the problem and that enables the students to organize their mental processes more effectively in the subsequent researches conducted in this area (Schoenfeld, 1985, Oladunni, 1998, Deseote, Roeyers and Buysee, 2001, Pugalee, 2001, Schurter, 2001, Kramarski, Mevarech and Arami, 2002).

The influence of the classroom environments in which students can comfortably express their thoughts is enormous in the development of problem solving and posing skills through mathematical reasoning. Students and teachers in the classroom should be open to questions, reactions, criticism. Students need to explain their own ideas and discuss them to show their correctness, recognize the deficiencies in their thoughts, and learn to criticize others' thoughts. Nevertheless, students need the experience of evaluating mathematical reasoning skills and developing their ability to discuss what they say in mathematical discussions. They need Professional guidance as well as time, diverse and rich experiences to be able to initiate a valid discussion and evaluate others' opinions. It is also clear that the development of reasoning skills can only take place in a classroom environment that focuses on this behavior (NCTM, 2000).

As mentioned above, the role of classroom discussions are important for development of reasoning ability and therefore on problem solving and building skills. However, when looking at the literature, it is seen that there is very little research conducting regarding the discussion-oriented teaching activities in mathematical environments.

One of the known discussion models is Toulmin's Discussion Model (Toulmin, 2003). The elements that make up Toulmin's discussion model are: (1) Data; the phenomena used to support the claim are as the cases used as evidence. (2) Claim; The results of established values, the value or the opinion of the present situation, as the view put forward. (3) Warrant; The rules that explain the link among the data and the claim or consequences as the rules, the principles. Pport the relationship between data and claim. (4) Backings; Basic assumptions confirming certain reasons, uncertain explanations on the basis of the hypothesis. (5) Qualifier; The cases in which the claims are accepted as true in specific situations, they restricted the boundaries of the claim. (6) Rebuttal; Specific cases where the claim is not true. The counter-arguments that are against data, claim, backings, qualifiers (Simon et al., 2006, Driver vedig., 2000, Van Eemeren, 1996).

According to Toulmin (2003), claims regarding new information are considered to be logical because of the establishment of the warrants given in the context of the data. The warrants are based on an interpretation of the data and backings. If a claim can be effectively argued with sufficient support, a claim is created and it is completed with qualifications that specify how and when the justification is applied to the observed events. This point of view is useful in determining the relationship between claims and evidence (Yerrick, 2000).

Several general strategies have been developed that can be used to support and facilitate the debate (Osborne et al., 2004A, 2004B; Erduran, 2007; Jimerez-Aleixandre, 2006). Strategies can be seen as patterns, discussion activities can be supported by taking the subject content, student profile and investigating which content should be matched with which pattern.

In the strategies used in the discussion process, the expressions asked by the teacher such as "Why do you think like that?; How do you know?; Do you have any evidence for that?; What is your evidence?; How do you refute the arguments outside your own opinion?; Are they important in terms of supporting the discussion as well as its encoring role for the participants. Some of these strategies are as follows: (1) Predict-Observe-Explain Strategy, (2) Expression Tables, (3) Concept Cartoons, (4) An Experimental Designs, (5) Argument Construction (6) Competing Theories.

When the relevant literature is examined, it is seen that there is a limited number of studies on the relationship between metacognition and problem-posing skills, those studies focus more on the relationship between metacognitive skills and problem-solving abilities (Schoenfeld, 1985; Lucangeli and Cornoldi 1997; Oladunni 1998; Deseote et al 2001 Pugalee 2001 Schurter, 2001, Kramarski, Mevarech and Arami, 2002, Garrett et al., (2006). In the related literature, it is also seen that the studies investigating the relationship among discussion-based learning environments and problem posing skills (Gillies and Khan, 2009) and metacognition (Mason and Santi, 1994) are also very limited.

The conceptual framework and related literature mentioned above show that; the studies involving the concepts of metacognition, problem, and discussion are mostly focused on the variables of the relationships between metacognition-problem solving skills, metacognition-discussion, discussion-problem solving skills, and they are especially zero on the problem-solving skills. Problem posing has been a less focused topic, as mentioned above. Moreover, in the vast majority of studies, it seems that studies on metacognitive skills are mainly carried out with the students in 4th grade or higher grades than this in primary schools. It is important to emphasize the extent in which the metacognition and discussion environments can give results for population for younger ages in terms of problem-solving abilities. In this context, the problem statement of the research is that *"Do the mathematical discussion environments supported by metacognitive questions have any effect on problem-posing skills of third grader students in primary schools?"* respectively. For this purpose, the following questions were sought:

The scores of the problem posing skills of the sub dimensions of participants consisting of individuals (some of the are in the Experiment 1 in which they are provided with the metacognitive support, some of them are in the Experiment 2 in which they are provided with lectures based on discussions and some of them are in Experiment 3 in which they are in control groups) labeled as "Realization of the Components of the Problem (RCP)", (Identification of the relationship between concept and operation (IRCC)", "Establishment of the problem requiring desired operation (EPRDO)" and "Posing problems based on the given visual and numerical data (PPGVN)".

1. Is there a significant difference between pretest scores?
2. Is there a significant difference between the final test scores?

2. Method

2.1 Model of the Research

This research was designed in an experimental model with pre-test and post-test control groups. The model can be defined as a well-grounded design frequently used in behavioral sciences that allows the interpretation of the findings in the cause-and-effect context, providing a high statistical power for the investigation of the effect of the experimental process on the dependent variable (Büyüköztürk, 2001). The design used in the research in Table 1 is shown by symbols.

Table 1: Experimental model used in research

Groups	Pre Test	Method	Post-test
EG_1	PPSS	Metacognitive Questions + DBLE (X1) (6 week)	PPSS
EG_2	PPSS	DBLE (X2) (6 week)	PPSS
CG	PPSS	Traditional Method (6 week)	PPSS

In Table 1, EG_1 stands for the experimental group 1, EG_2 stands for the experimental group 2, CG stands for control group; PPSS (Problem posing skills scale) stands for the Pre-test and post-test measurements of the experimental and control groups, X1, independent variable applied to the subjects in Experimental group 1 (it indicates discussion based learning environments supported by metacognitive questions); X2 refers to the other independent variable in the Experiment 2 group (it refers discussion-based learning environments only). Moreover, it is seen that the teaching activities held in experimental and control groups in Table 1 are continued for 6 weeks.

2.2 Participant Characteristics and Sampling Procedures

The study group consists of 52 students at the 3th grade level, Güneybağ Primary School and Gürağaç Primary School in Konya, Güneysınır District in the 2015-2016 academic year. 3-A class in Güneybağ Primary School is determined as a control group (n=17), 3-B class in Güneybağ Primary School is determined as an experimental group 1(N=17) and 3-A class in Güneybağ Primary School is determined as an experimental group 2 (N = 18). The schools and branches in which the students of the study group were determined by convenient sampling method among the primary schools located in the center of Güneysınır district of Konya. The main reason why this research is conducted in these specified provinces and districts is to create an easily reachable study group, thus making the research more economical and efficient (Yıldırım and Şimşek, 2006). As a prestudy on the equivalence of experimental and control groups, the opinions of the teachers and administrators in the primary schools were taken and the mathematical achievement averages of the groups were examined and it was determined that there was no significant difference between the groups. Table 2 lists some of the characteristics of the groups.

Table 2: Information about Experiment and Control Group

Gender	**Experiment Group 1**		**Experiment Group 2**		**Control Group**	
	f	**%**	**f**	**%**	**f**	**%**
Female	9	53	9	50	8	47
Male	8	47	9	50	9	53
Total	17	100	18	100	17	100

2.3 Data Collection Tools

Problem Posing Skills Scale (PPSS): The scale used as pre and post-test was developed by researchers in order to determine the level of problem posing skills of 3th grade elementary school students and to determine the differences among the methods. The scale consists of 6 sub-dimensions proposed by Stoyanova and Ellerton (1996): There are 12 items in the scale, 3 of which are multiple choice, 2 items are fill in the blanks type questions and 7 items are open-ended. Structures of the items are prepared in semi-structured form (Christou et al., 2005). The distribution of the items in terms of scale sub-dimensions is presented in Table 3.

Table 3: Distribution of the Items according to the Sub-Dimensions of Tests for Problem Posing Skills

Sub Dimensions	**Item No**
Realization of the Components of the Problem (RCP)	1,2,3
Identification of the relationship between concept and operation (IRCC)	4 (a,b,c,d,e)
Posing a Similar Problem (PSP)	5
Completing the incomplete problem (CİP)	6 (a,b,c,d)
Posing the problem requiring desired operation (EPRDO)	7,8,9
Posing problems based on the given visual and numerical data (PPGVN)	10,11,12

To increase the validity and reliability of the scale, the test form was presented to 10 domain experts and 2 experts in measurement evaluation. They were asked to evaluate the questions the experts according to the 4 criteria presented in Table 3. The issues which were approved by experts and not commonly accepted by them based on these criteria were discussed and the necessary arrangements were made. To calculate the reliability of the study, a reliability formula of [(reliability = consensus/(consensus+ dissidence)] was used, as proposed by Miles and Huberman (1994). As a result of the calculations made, the obtained data on the reliability of the study are presented in Table 4. The scale was considered reliable because it accounts for more than 70% of the reliability coefficients (Miles and Huberman, 1994).

Table 4: Coefficients of Reliability of the Scale

Evaluation Criteria	**Consensus**	**Dissidence**	**Reliability Coefficient**
Can the material represent the characteristic of the items that will be measured?	11	1	0,92
Can the material be easily understood by the target audience?	10	2	0,83
Are the item clearly expressed?	10	2	0,83
Can the items be placed at a predetermined dimension?	9	3	0,75

The test-retest method was used to examine consistency of the 12-item scale in terms of time. The scale was applied to 70 primary school students twice with 4 week intervals and the Pearson Moments multiplication correlation coefficient was calculated as 0.84 ($p < 0.001$). This result shows that the scale is also reliable in terms of the test scores.

In addition to the above studies, a content validity study has been carried out by Lawshe (1975) technique. In this research, the opinions of the 12 experts mentioned above were applied. Experts rated each item as "measuring the target structure", "item is related with the structure, but unnecessary" or "substance does not measure what is being targeted". As a result of these ratings, experts' opinions on any item have been collected and validity rates have been obtained. Content validity ratios (CVR) were calculated for each item individually using the formula presented in Figure 1.

$$KGO = \frac{N_G}{N/2} - 1$$

N_G: Gerekli diyen uzmanların sayısı
N: Araştırmaya katılan uzmanların toplam sayısı

Figure 1: Content Validity Ratio (CVR)

The calculated Content Validity Ratios are presented in Table 5.

Table 5: Content Validity Ratios of the Experimental Scale (KGO)

Item No	Necessary	Useful/ Unnecessary	Unnecessary	KGO
1	11	1	0	0,83
2	11	1	0	0,83
3	11	1	0	0,83
4	12	0	0	1,00
5	10	1	1	0,66
6	10	2	0	0,66
7	10	1	1	0,66
8	11	1	0	0,83
9	10	1	1	0,66
10	10	1	1	0,66
11	11	1	0	0,83
12	10	2	0	0,66

It was decided that the content validity of the scale items was statistically significant, since the total CVRs obtained for each substance were bigger than 0.56 as Content Validity Criterion for 12 expert opinions in the literature (Veneziano and Hooper, 1997). Then the average of all CVRs is calculated and the result is the Content Validity Index (CVI) as 0.76 for the whole scale. The fact that the value of CVI is higher than 0.56 was considered to be an indication that the scale had suitable content validity.

2.4 Experimental Manipulations or Interventions

At the beginning of the application, the necessary information about the purpose and functioning of the research was briefly introduced to the teachers and the problems that required knowledge for four operations collecting as subtracting, multiplying and dividing for its solution at 3rd grade level, were determined.

Eight problems were determined for these four operations and, three of these problems were randomly selected among these problems, and the solution of the problem was solved under the guidance of the teachers. In addition, students have come together with their group mates to solve the problem of the remaining five problems in extra-curricular times. The study was conducted by the teachers of the classes, in which one was designed as a control group, and two of them was designed as experimental group, it was provided that each group in the classes consisting from 4 individuals. The methods that varied from groups to groups during the problem solving process are stated below.

When the DBLE method is applied in the experimental groups, the model of competing theories is used. Based on the work of Solomon (1991) and Solomon et al. (1992), one of the problems mentioned above is presented to students in this strategy. At least two competing theories for problem solution are given. Some evidence that supports one or all of them, or none of them among these theories are presented, and the groups are given time to think in small groups on these evidence and choose the theory that suits them. Later, the students defended their theories and evidence they chose in the debate process and tried to disprove the other side's theory.

In experiment group 1, the above-described DBLE method was supported by metacognitive questions and problem solving / setting activities were carried out. During the solution of each problem presented to the students, a guidance card containing the steps of DBLE method and supported questions with metacognitive questions were distributed and students were asked to write the answers they gave to these questions on the card. Some examples of these questions are: reflective questions (what is the problem about?), Synthesis questions (which are different / different from the ones we have already solved), strategic questions (which strategies are appropriate to solve the given problem, why?), Can this question be interpreted differently?; did I have all the information in sight?)

In only experiment group 2, problem solving and DBLE activities were both performed. During the solution of each problem presented to the students, a guidance card containing the steps of the DBLE method and questions about these steps was distributed and students were asked to write the answers they gave on these questions on the card.

Teachers were presenting explanations about the usage of cards and examining the answers students wrote on the cards during the course. After this stage, students are asked to discuss their suggestions with their group mates about the problems at the point they have encountered in the guidance card.

Later, the teachers wrote the different solution ways on the cards if there are different ways and their own solution methods on the board, and this time they asked the students to make a comparison between the solutions on the board and their solutions. Thus, after discussing the solutions for a while, the relevant sections of the guidance card have been filled in. Lastly, students were asked to pose a similar problem and to discuss verbally on the problems they posed. In addition, students were provided with guidance cards for problems they solved and posed in the meetings outside the classroom, and to enable them to discuss on them.

The lesson, on the other hand, was planned on the basis of the Elementary 3 rd Year Mathematics Guidebook for the control group. Teachers and students have already done problem solving and posing activities as they have done before. Activities lasted 6 hours, 4 hours per week, totaling 24 hours.

2.5 Analysis of Data

Research data was entered into the computer using SPSS 18.0 program. The One Sample Kolmogrov-Simirnov test was used to check whether the groups had a normal distribution for pre-test and post-test averages. One-Way ANOVA (One Way ANOVA) was performed to compare pre and post-test averages of the control and experimental groups. Apart from this, descriptive statistics have been calculated and interpreted.

3. Results

The results of the ANOVA conducted to determine whether there is a significant difference between the scores of the students' on the dimension of "Realization of the Components of the Problem" in problem posing skills are given in Table 6 when the pre-test and post-test scores of Experimental Group 1, Experimental Group 2 and Control group students are taken into account.

Table 6: ANOVA results regarding the dimension of "Realization of the Components of the Problem" in problem posing skills

Dimensions		Sum of squares	Sd	Squares Average	F	P	DBG
Realization of the Components of the Problem (Pre-Test)	Between groups	.208	2	.104	.381	.685	-
	In-groups	13.357	49	.273			
	Total	13.564	51				
Realization of the Components of the Problem (Post-Test)	Between groups	1.886	2	.943	3.897	.027	1-3
	In-group	11.858	49	.242			2-3
	Total	13.744	51				1-2

p<.05; DBG= Difference between Groups

When the data presented in Table 6 were examined, it was determined that there was no statistically significant difference among pre-test scores of Experiment 1, Experiment 2 and Control groups. This result can be interpreted as the fact that the students in all groups are equal in terms of their ability to be aware of the problem components in problem setting. It can be seen that there is a difference between the post-test scores of the students in the study groups in Table 6. When LSD test results determining the source of the difference are evaluated, it is seen that there is a significant difference among Experimental Group 1 and Experimental Group 2 and Control group in favor of experiment groups and there is a difference between Experimental Group 1 and Experimental Group 2 groups in favor of Experiment 1 group.

It can be interpreted that the results of Experimental group 1 in which the metacognition-supported debate-based learning environments used and the results of Experimental group 2 in which the discussion-based learning environments conducted significantly develop students' level of "Realization of the Components of the Problem" in problem solving compared to the results of the control group in which the same curricular activities were conducted based on the results of this study.

Table 7: The Results of the Analysis of Variance Analysis Results of the Dimension of "Identification of the relationship between concept and operation (IRCC)"

Dimensions		Sum of squares	Sd	Squares Average	F	P	DBG
Identification of the relationship between concept and operation (IRCC) (Pre-test)	Between groups	.092	2	.046	.352	.705	-
	In-group	6.427	49	.131			
	Total	6.519	51				
Identification of the relationship between concept and operation (IRCC) (Post-test)	Between groups	2.332	2	1.166	3.042	.001	1-3 1-2
	In-group	7.105	49	.145			
	Total	9.437	51				

$p<.05$; DBG= Difference between Groups

When the data presented in Table 7 were examined, it was determined that there was no statistically significant difference among pre-test scores of Experimental Group 1, Experimental Group 2 and Control groups. This result can be interpreted as the fact that the students in all groups are equal in terms of their ability to demonstrate relationship between concept and operation in problem-solving. Similarly, in Table 7, there is a difference between the post-test scores of the students in the study groups. When LSD test results determining the source of difference were evaluated, it is seen that there is a significant difference between Experimental Group 1 and Experimental Group 2 groups in favor of Experiment 1 and there is a significant difference between Experimental Group 1 and Control Group in favor of Experimental Group 1 group. There was no statistically significant difference between experiment 2 and control group. It can be interpreted that the results of Experimental group 1 in which the metacognition-supported debate-based learning environments used and significantly develop students' level of identification of the relationship between concept and operation in problem solving compared to the results of Experimental Group 2 in which the discussion-based learning environments conducted and the results of the control group in which the same curricular activities were conducted based on the results of this study.

Table 8: The Results of Analysis of Variance Analysis Results of the Dimension of "Posing a Similar Problem (PSP)"

Dimensions		**Sum of squares**	**Sd**	**Squares Average**	**F**	**P**	**DBG**
Posing a Similar Problem (PSP) (Pre-test)	Between groups	3.459	2	1.730	2.693	.078	-
	In-group	31.464	49	.642			
	Total	34.923	51				
Posing a Similar Problem (PSP) (Post-test)	Between groups	1.441	2	.721	1.822	.173	-
	In-group	19.386	49	.396			
	Total	20.827	51				

p<.05; DBG= Difference between Groups

When the data presented in Table 8 were examined, it was determined that there was no statistically significant difference among the pre-test scores of the Experimental Group 1, the Experimental Group 2 and the control groups and between the post-test scores. This result can be interpreted as the fact that the students in all groups are equal before and after the experimental process in terms of their ability to create a similar problem in problem solving. In other words, it can be interpreted that the effects of the instructional method applied in Experimental group 1 in which the metacognition-supported debate-based learning environments used and the effects of the instructional method applied in Experimental Group 2 in which the discussion-based learning environments conducted and the effects of the instructional method applied in the control group in which the same curricular activities were conducted, are not statistically differed in terms of the dimension of "Posing a Similar Problem (PSP)".

Table 9: The Results of Analysis of Variance Analysis Results of the Dimension of Completing the Incomplete Problem

Dimensions		**Sum of squares**	**Sd**	**Squares Average**	**F**	**PDBG**	
Completing the Incomplete Problem (Pre-test)	Between groups	.736	2	.368	1.020	.368	-
	In group	17.672	49	.361			
	Total	18.407	51				
Completing the Incomplete Problem (Post Test)		.526	2	.263	.682	.510	-
	In group	18.897	49	.386			
	Total	19.423	51				

p<.05; DBG = Difference between Groups

When the data presented in Table 9 were examined, it was determined that there was no statistically significant difference between the pre-test scores of the Experiment 1, the Experiment 2 and the control groups and the post-test scores. This result can be interpreted as the fact that the students in all groups are equal in terms of the ability to complete the incomplete problem in problem posing before and after the experimental process. In other words, it can be said that, the effects of metacognition-based discussion-based learning environments (Experimental Group 1), discussion-based learning environments (Experimental Group 2) and teaching environments (Control Group) over the learning of the students did not differ statistically with regard to their ability to complete the incomplete problem. Moreover, when we look at the arithmetic mean, it is seen that the average score of all groups increased.

Table 10: The Results of Analysis of Variance Analysis Results of the Dimension of "Posing the problem requiring desired operation (EPRDO)"

Dimensions		**Sum of squares**	**Sd**	**Squares Average**	**F**	**P**	**DBG**
Posing the problem requiring desired operation (EPRDO) Pre-test	Between groups	.811	2	.405	.776	.466	-
	In group	25.608	49	.523			
	Total	26.419	51				
Posing the problem requiring desired operation (EPRDO) Post-test	Between groups	6.337	2	3.168	5.420	.007	1-3
	In group	28.644	49	.585			
	Total	34.981	51				

p<.05; DBG = Difference between Groups

When the data presented in Table 10 were examined, it was determined that there was no statistically significant difference among pre-test scores of Experiment 1, Experiment 2 and Control groups. This result can be interpreted as the fact that the students in all groups are equal in terms of the posing the problem requiring desired operation. Table 10 also shows the difference between the post-test scores of the students in the study groups. When the LSD test results determining the source of the difference were evaluated, there was only a difference between Experimental Group 1 and Control group in favor of Experimental Group 1 group. The differences between Experimental Group 1 and Experimental Group 2 as well as Experimental Group 2 and Control group are not statistically significant. This conclusion can be interpreted as; the students significantly developed more their posing skills regarding the problem requiring desired operation in a metacognitive-based discussion instruction conducted in the experimental group 1 than the control group. When the arithmetic mean is taken into account, it is seen that all groups have an increase in their averages of the post test scores with respect to their pre-test point averages.

Table 11: The Results of Analysis of Variance Analysis Results of the Dimension of Posing problems based on the given visual and numerical data (PPGVN)

Dimensions		Sum of squares	Sd	Squares Average	F	P	DBG
Posing problems based on the given visual and numerical data (PPGVN) pre-test	Between groups	1.305	2	.653	1.094	.343	-
	In group	29.225	49	.596			
	Total	30.530	51				
Posing problems based on the given visual and numerical data (PPGVN) post-test	Between groups	4.772	2	2.386	3.371	.042	1-3 1-2
	In group	34.681	49	.708			
	Total	39.453	51				

p<.05; DBG = Difference between Groups

When the data presented in Table 11 were examined, it was determined that there was no statistically significant difference among pre-test scores of Experiment 1, Experiment 2 and Control groups. This result can be interpreted as the fact that the students in all groups are equal in terms of the posing the problem requiring desired operation. Table 10 also shows the difference between the post-test scores of the students in the study groups. When the LSD test results determining the source of the difference were evaluated, it is seen that there is a significant difference between Experimental Group 1 and Experimental Group 2 groups in favor of Experiment 1 and there is a significant difference between Experimental Group 1 and Control Group in favor of Experiment 1 group. It was also found that there was no significant difference between Experimental Group 2 and Control Group.

It can be interpreted that the results of Experimental Group 1 in which the metacognition-supported debate-based learning environments used and significantly develop students' level of their skills regarding posing problems based on the given visual and numerical data compared to the results of Experimental Group 2 in which the discussion-based learning environments conducted and the results of the control group in which the same curricular activities were conducted based on the results of this study.

Table 12: The Results of Analysis of Variance Analysis Results of the Total Scores in terms of Problem Posing Skills

Dimensions		Sum of squares	Sd	Squares Average	F	PDBG	
Problem Posing Skills (Pre-test)	Between groups	.507	2	.254	1.168	.320	-
	In group	10.644	49	.217			
	Total	11.151	51				
Problem Posing Skills (Post-test)	Between groups	2.304	2	1.152	4.979	.011	1-3 1-2
	In group	11.338	49	.231			
	Total	13.642	51				

p<.05; DBG = Difference between Groups

When the data on the total scores of the problem-posing skills in Table 12 are analyzed, it can be seen that there is no significant difference between the test and control groups in terms of pre-test scores and it is seen that there is a significant difference for the post test scores in favor of Experimental Group 1. When the arithmetic average is examined, it is seen that the average scores of all groups are increased.

When the data presented in Table 12 were examined, it was determined that there was no statistically significant difference among the pre-test scores of Experimental Group 1, Experimental Group 2 and Control groups. This result can be interpreted as the fact that the students in all groups are equal in terms of problem-posing abilities, which is explained by the points they get from the whole scale. Table 12 also shows the difference between the post-test scores of the students in the study groups. When LSD test results determining the source of difference were evaluated, it is seen that there are significant differences between Experimental Group 1 and Experiment 2 groups in favor of Experimental Group 1 and between Experimental Group 1 and Control Group in favor of Experimental Group 1 group. There was no statistically significant difference between Experimental Group t 2 and control group. This conclusion can be interpreted as the fact that the metacognitive supported learning environment in Experiment 1 group developed statistically significantly more problem-building skills than the control group in which the instructional activities of the curriculum were conducted and the discussion-based learning environments conducted in Experimental Group 2.

4. Discussion and Recommendations

According to the findings of this research that the mathematical discussion environments supported by metacognitive questions are affected by problem-posing skills of primary school third graders, it is seen that the mathematical discussion environments supported by metacognitive questions have a significant difference in the dimensions of "Realization of the Components of the Problem (RCP)", "Identification of the relationship between concept and operation (IRCC)", "Posing the problem requiring desired operation (EPRDO)" and "Posing problems based on the given visual and numerical data (PPGVN)" in favor of experiment 1 group. The mathematical discussion environments supported by metacognitive questions has not been found to be significantly different from the other learning environments in this study in other dimensions of problem-posing skills as "Posing a Similar Problem (PSP)" and "Completing the incomplete problem (CIP)"

According to the results obtained from the analysis results of the dimension of problem items "Realization of the Components of the Problem (RCP)" which is the first dimension of the problem-posing skill, it is seen that the post test score averages differ significantly in favor of experiment 1 group. From this point of view, it can be said that the instruction method investigated in this study can be regarded as an effective method in the future studies regarding the dimension of problem posing skills labelled as “Realization of the Components of the Problem (RCP)" which are basically existent in the structure of the problem.

When the pretest-posttest scores of the groups for the second dimension labelled as "Identification of the relationship between concept and operation (IRCC)" were compared, it was seen that there was a significant difference in favor of experimental group I. It can be interpreted from this finding that mathematical discussion environments supported by metacognitive questions may have a positive effect of their ability for establishing the connection between concepts and operations in the problem-setting process of the 3th grade elementary school students.

When the findings related to the dimension of "Posing a Similar Problem (PSP)" are examined, it can be said that the instruction method used investigated in this study can be an alternative method to improve the ability of the third grade students of the primary education for posing similar problems by the way of the example problem given.

According to the results obtained from the findings related to the fourth dimension of “Completing the incomplete problem (CIP)”, it is seen that all groups have an increase in the average of points, but there is not a significant difference between the groups. This may show that the traditional method of argumentation supported by metacognitive questions about the ability to complete the missing problem may be an alternative method.

When the findings related to the dimension as “Posing the problem requiring desired operation (EPRDO)” were examined, it is seen that the groups had a significant difference in favor of the experiment 1 group in terms of pre-test and post-test point averages. According to this analysis, it can be said that the teaching method based on acquiring the problem-posing ability for a problematic case in which the steps to be used in the solution of the problem are given can be regarded as an effective method.

When we look at the findings of “Posing problems based on the given visual and numerical data (PPGVN)”, there is a significant difference between the post test scores in favor of the deny group 1 while there is no significant difference in the pre-test scores of the groups. According to this, it can be said that the mathematical discussion method supported by metacognitive questions is effective in the development of the problem-posing ability in the dimension of “Posing problems based on the given visual and numerical data (PPGVN)”.

When Experiment 1, Experiment 2 and control groups were generally evaluated in terms of pre-test and post-test point averages, it can be said that the discussion method supported by the metacognitive questions was more effective in improving problem-solving ability than the traditional method applied in the control group. This supports the finding of Mason and Santi (1994) that indicated 'the deepest discussions emerge from the highest levels of metacognitive thinking'. In addition, the fact that there is no statistically significant difference in the dimensions of "Posing a Similar Problem (PSP)" and "Completing the incomplete problem (CİP)" can be attributed the levels of learning readiness, cognitive processes and the adequacy of other methods.

In the interviews with the class teachers of the experimental groups, the teachers working with the experiment 1 and the experiment 2 group stated that they enjoyed the application during the process, reported that students were willing to answer the metaphorical questions directed to themselves and that the discussion environment was beneficial for increasing the students' awareness. Teachers have also stated that the process should be kept a little longer, and that the time allocated in the curriculum is not sufficient for the full implementation. It can be said that discussion method supported by metacognitive questions is an alternative, entertaining and effective method that can be evaluated by making appropriate planning for the problematic structure of the.

This study examines the effects of discussion environments supported by metacognitive questions on the problem-setting ability of 3th grade primary school students, and it can be re-investigated with both on the problem-setting skills of the 4th grade primary school students and on the problem-solving skills of the 3rd and 4th grade students. Models based on the methodology can be developed and appropriately planned in the curriculum. The effectiveness of the discussion method supported by metacognitive questions can be investigated in order to obtain other mathematical gains. It can be applied to different level groups to investigate the effect of the method on the groups.

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