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Reflections of Problem Solving Environment Based on Group Work: Example of Fibonacci Problem

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Abstract: In this study, reflections of problem solving environment based on group work are presented. Samples of the study are 28 students studying on 9th grade of a secondary school in Trabzon. In this study a historical problem of Fibonacci in his book "Liber Abaci" arranged appropriately to the problem solving steps of Polya and a worksheet was designed. Worksheet was applicated to the students during two lesson hours in pairs. The written opinions of students were taken after the application. When data is generally evaluated, it is seen that students only have difficulties in understanding the problem step because it is given just only linguistically. When worksheets are evaluated, it is seen that students get the lowest marks in evaluating the problem step. At the end of the study, it is advised to the teachers to use historical problems and problem solving activities based on group working in their lessons.

Keywords: Mathematics education, group work, problem solving, historical problem.

To educate individuals enough to be able to overcome the problems they can meet during their lives is one of the prior purposes of education (Baki, Karataş & Güven, 2002). Mathematics educationists are agreed on improving problem solving skills of students and counting this as one of the prior purposes of education (Charles & Lester, 1982). That's why problem solving plays a central role in mathematics teaching programs. With the elementary mathematics instructional program renewed and put into action in Turkey in 2005, problem solving is counted as an integral part of mathematics education and stated as a basic skill of students which can be improved for every subject (MNE, 2009).

Since problem solving makes an individual think of a situation, individuals have to form a new idea for each problem they meet. From this point of view it can be said that there is thinking in all situations problem solving occurred (Yeşildere & Türnüklü, 2007). Because the process of understanding the mathematical knowledge and forming relations between that knowledge gained happens during problem solving process. Solving a problem is a process and method of using knowledge with a new and non-routine way (Gür & Korkmaz, 2003). So in problem solving based learning environments while individuals are looking for the solution methods to the problems, they also use their present knowledge. When students meet a problem, they explain, analyze and give a meaning to the given knowledge. That's why mathematical understanding of students improves and deepens during problem solving process (Baki, 2008).

Using different problem solving methods of famous mathematicians may help students to improve their problem solving skills (Karakuş, 2009). From this point of view history of mathematics is an excellent source of historical problems that alert problem solving skills of students (Wilson & Chauvot, 2000). Historical problems show students the ancient ways and techniques of problem solving. Also solution of historical problems may be useful for their own problems and may give new

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ideas to them (Savizi, 2007). In this context, a historical problem is arranged suitable to the Polya (1997)'s problem solving steps and reflections from problem solving environment depending on the group working are presented in this study.

Method

Since it is focused on a special situation and tried to work on the studied situation deeply (Çepni, 2007) case study method is used in this study.

Participants

The study was conducted with 28 students who were 9th grade at a secondary school in Trabzon during the spring term of 2011-2012 school year.

Data collection tools

Observation. Since the students are observed without using a form in their natural environments, unstructured observations are done in this study. The aim of the observation during the research is examining the steps of students in problem solving process so during the observation researcher focuses on students' behaivours on problem solving steps. Studies of students are observed during the application process by the researchers and they try to gain detailed information by walking around the groups.

Written views of students. At the end of the study written opinions of students are taken. Students are requested to state their positive or negative opinions about the activity applied.

Worksheet. Firstly the problem that will be used for problem solving activity is identified. To take interest of students and show them both ancient problem solving techniques and ways, a problem from Fibonacci's "Liber Abaci" book (Two towers, the heights of which are 30 paces and 40 paces, have a 50 paces distance. Between the two towers there is a font where two birds, flying down from the two towers at the same speed will arrive at the same time. What is the distance of the font from the two towers?) is arranged according to Polya's problem solving steps in the study. A teacher and two academician helped for the validation study of the worksheet. The worksheet examined by teacher and academicians is re-arranged according to the taken feedbacks. Also with the pilot study the worksheet reached its last form.

There are 11 questions on the worksheet. First five questions are about understanding the problem, 6th problem is about devising a plan, 7th problem is about carrying out the plan, 8th, 9th and 10th questions are about looking back and 11th problem is about putting forward a new problem. There are questions such as "read the problem and tell your group friends what you understand", "what are given in the problem?", "what is wanted to find in the question problem?", "is there a missing or unnecessary knowledge in the problem?" to find if the students understand the question problem or not in understanding the problem step. In devising a plan step it is aimed to make students develop a method for solving the problem by asking them the problem "what kind of a solution way can you develop by using the given information in the problem?". In carrying out the plan step students are asked to carry out the plan they prepared. In looking back step it is tried to make students think about the possible different result they got by asking questions such as "what does the result you found mean?", "how can you be sure about the accuracy of your solution?", "can you solve this problem in another way?".

Implementation of Worksheet

Information about the study that will be done is given to the students before the application. That's why students are informed about the problems on the worksheet too. Later with the distribution of the worksheets, students are made to think of the problems by working in pairs. Researchers walked among the students and they guide them when students need during the studying process of the students.

Data analysis

Observation notes are transferred to the computers just after the applications by the researchers. Later the observation notes that fit the purpose of the study are directly given in the results. The written views of the students are presented directly as the citations to support observation data.

To evaluate the worksheets "The Problem Solving Evaluation Scale" prepared by Baki (2008) is used. The maximum point that can be taken on evaluation of the scale is 15 and the minimum is 0. Points taken between 0-3 are evaluated as "weak", 4-7 as "middle", 8-11 as "good", and 12-15 as "very good".

Results

Firstly observation notes and written student opinions and then data gathered from worksheets are presented.

Findings gathered from observation data and written opinions of students

Students seem to have difficulties in *understanding the problem* step. The reason of this may be that the figure of the problem is not given to the students and students are asked to form the solution way themselves after understanding the problem and reach the solution by drawing the figure themselves. It is also observed that one of the reasons of not understanding the problem is the lack of pre knowledge (X=V.t) of students about physics. Thus during the class observations it is seen that since students don't know the birds who are wanted to reach the light source will have the same way to go, they live difficulties. At this step students are helped to understand the problem by the necessary guidance.

At the *devising a plan* step 8 groups seem drawing figures and setting equations to reach the solution but the rest 6 groups seem not to be able to plan. Thus this situation is observed on worksheets too. For example the figure and equation a group set for the solution of the problem is as the following:

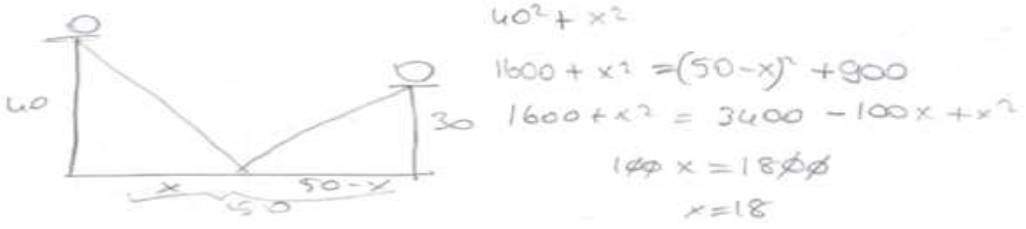

Figure 1.The figure and the equation a group set for planning

At *carrying out the plan* step students try to apply the plan they prepared. They try to reach the solution by solving the equation they set with the help of figure they drew. In Figure 2 it can be seen how a group found the solution by the help of equation they set and figure they drew.

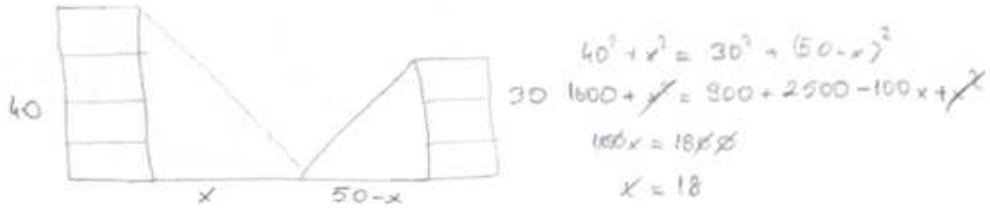

Figure 2. The solution of a group they found by the help of the equation they set and the figure they drew

At *the looking back* step students searched if their solution is right or not with the directions of instructions on worksheet and if there are different solution ways or not. To be sure if their solutions are right or not, 9 groups preferred to crosscheck their solutions. For example a group did the following to test if the solution is right or not:

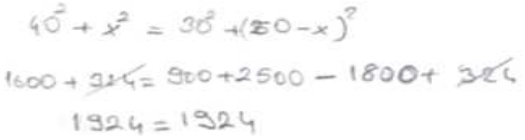

Figure 3. Thing a group did to test the rightness of the solution way

At *looking back* step only 4 groups could succeed testing if their solution is right or not. Also 13 groups seem to be inadequate in finding a solution way. Only a group tried to use similarity in solution of the problem as a different way but they couldn't complete the solution. The solution this group tried to do is as this:

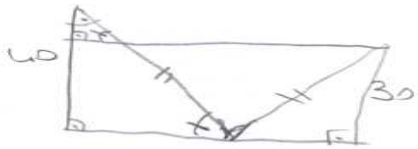

Figure 4. Solution of a group related to similarity

In posing a new problem step only 4 groups posed similar problems, 6 groups made logic error in problem formation and 4 groups couldn't succeed to pose a problem. It is seen that the groups who posed similiar problems changed the numbers or names in the problems given to them. For example the problem a group posed with changing the names in the problem given is as in Figure 5:

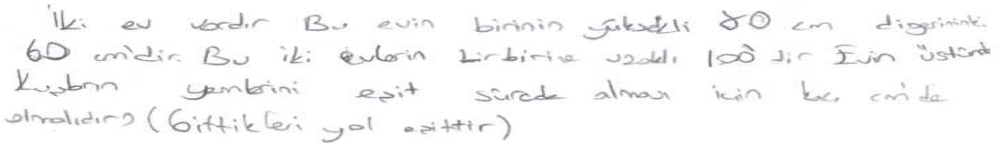

Figure 5. A new problem posed by a group

After students complete the practice, groups came to the board, shared their solutions with their friends and discussed different solution ways. Later some leading questions were asked to students to make them find his own solution way of Fibonacci he used for the problem and make made them discover the solution way of Fibonacci. It is observed that students effected much by the solution way where unknown didn't used and they found this solution method very effective. Thus they expressed this in their written opinions. For example the view of a student say in that there is no need to do operations every time to solve a problem, the problem can also be solved by trial and error method is remarkable as "*We may not be able to solve every mathematics problem by mathematical operations on this lesson. So we may need to use trial and error way a bit.*". Sentences of another student as "*...Idea of Fibonacci effected me much and came to me very easy. It was a teaching practice.*" show how much he effected by the

solution way.

Findings obtained by analytical review of student worksheets

Points 14 groups have as the evaluation of worksheets presented in Table I.

Table I

The evaluation criteria used to analyze the worksheets according to problem solving process

	Groups	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Sum
Steps	Understanding the Problem	2	3	3	3	2	3	2	3	2	2	2	2	2	2	33
	Devising a Plan	3	3	0	2	3	2	2	0	3	0	3	0	0	0	21
	Carrying out Plan	0	3	3	3	2	2	2	3	2	1	2	0	3	0	26
	Looking Back	0	1	2	1	0	1	1	2	0	2	0	0	2	1	13
	Posing a New Problem	2	2	1	1	2	1	2	1	0	0	0	0	1	1	14
	Sum	7	12	9	10	9	9	9	9	7	5	7	2	8	4	107

When the sum of all groups points are examined in Table I, groups seem to be successful at most at understanding the problem step and at least at looking back step. When the points groups took are examined separately, 5 groups seem to be in middle and 7 groups seem to be in good points range.

Discussion, conclusion and recommendation

9th class students seem to have difficulties much at understanding the problem step and looking back step in this study. The reason of the fact of students living difficulties at understanding the problem step can be thought that students are not used to solving the verbal problems. Similiar situations are told in different studies too (Gür & Korkmaz, 2003; Soylu & Soylu, 2006). Since the students are not able to find different solution methods and posing new original problems they are not successful at looking back and posing a new problem steps. To make students produce different solution ways and grow up as a good problem solver, teachers have to use problems that can be solved by different solution methods on their lessons at schools and they have to support their students to think about different solutions. Thus Gür and Korkmaz (2003) state students living difficulties in problem solving are not successful in posing a new problem either and teachers have to focus on posing a new problem, finding a solution to the problem and recording all the ideas about the problem. Historical problems make students to reveal problem solving strategies and improve their mathematical skills. Also they show how the solution process of a problem continued. Because of these using historical problems on lessons make students understand the problem solving process more and help to improve their problem solving skills.

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