The teaching-learning of mathematical case problems through problem solving approach for elementary school students

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Abstract: *The aims of the study were to: (1) improve the students' understanding in solving mathematical case problems, (2) improve the students' achievement by problem-solving strategies according to the types of the mathematical case problems, and (3) know the process of teaching–learning about that teaching-learning model. The research method used was classroom action research. The study consisted of two cycles. Each cycle consisted of plan, action, observation, and reflection. The research subjects were 32 students of the fifth grade of the Public Elementary School of Kota Gede V Yogyakarta. The research instruments were a pretest, an achievement test, and an observation sheet. The qualitative data collected through observations and direct interviews were qualitatively analyzed and interpreted, whereas the quantitative data were quantitatively described. The result of the first cycle was not satisfactory; the mean score of the posttest was only 61,5, whereas the mean score of the pretest was 41. In the second cycle, the mean score was 78,00, above the stipulated criteria. The teaching-learning process ran as expected.*

Keywords: *mathematical case problems, problem solving, students' achievement*

1. Introduction

Mathematical case problems are the application of mathematical concepts in real daily life. More than 75% of elementary school students face difficulties in solving mathematical case problems. Data and information show that students' achievement in the mathematical subject at the elementary, secondary, and high schools are commonly low; especially in solving the mathematical case problems or essay tests which are usually in the form of mathematical case problems (Wim, 1995: 1). Another similar statement shows that when the elementary school students did the test, they usually complained when they faced difficulties in solving case problems. (Sardjono, 1986: 22). Wakiman's research results (1995: 28) about elementary school student teachers in the 1993 academic year show that their understanding about mathematical case problems was still low. Endang Retno Winarti (1998: 3) carried out a study on the types of problems faced by elementary school students and found out that the main problem was solving case problems; especially about applied problems, while most of them were problem solving materials. She stated that translation errors, understanding case problems and problem solving strategy still became obstacles for them.

Based on the researcher's experience when he guided students doing the teaching

practices at elementary schools, especially at the public elementary school of Kota Gede 5 Yogyakarta, the mathematical materials that were still difficult for students were mathematical case problems, because they were concerned with the real application of mathematical concepts to real life.

The importance of problem solving in the mathematical teaching-learning process was stated by Kennedy and Tipps (19954: 137) that mathematics was not only a group of concepts and facts, but it was a process that was studied and implemented to search for the solution of problems. According to Abdullah (2000: 37) one of the main aims of learning mathematics was in order that students were able to have the ability to solve problems. Branca (Alam and Pathudin, 2002: 60) stated that the ability of problem solving was the common aim and basic ability in the mathematical teaching and learning. It means that the problem solving had an important and main role in the mathematical teaching and learning.

There were empirical teaching and learning actions that showed that mathematical teaching-learning by problem solving could give positive results. The research results of Guernon and Wooten (Sujimat, 2000: 7) found that students who were taught by problem solving had a good ability in solving problems compared to those who did not. A similar study carried out by Priatna (2000: 45) showed that problem the solving approach was significantly better than the conventional approach. Based on the importance of the problem solving approach in mathematical teaching and learning, and similar problems that happened in Kota Gede 5 public elementary school, the researcher was eager to carry out the problem solving approach in the teaching–learning of mathematical case problems.

Based on the background case and problems described above, the research problems could be constructed as follows:

1. How could the teaching and learning of mathematical case problems be improved by a problem solving approach?
2. Was the problem solving approach able to improve the students' achievement in solving the mathematical case problems?
3. How did the students respond to the teaching-learning of mathematical case problems through a problem solving approach?

Mathematical case problems are problems of mathematical concept applications in real life. Though they are in the form of simple stories, those are commonly related to problem solving. If a student understands a case problem, it means that he could change the information of the case into statements or mathematical sentences; he could change certain words into symbols; and he could interpret the equation and the tendency of diagrams and the like. (Rusefendi, 1998: 53).

According to Cooney. J. (1975: 227-229) a student may have difficulty to understand mathematical case problems because of the following factors:

1. Low knowledge about concepts, includeing the meaning of words or certain terms;
2. Inability of expressing the case problems in his own words including expressing what is given and what is asked as well as mathematical connection` between them;
3. Low knowledge about principles that can be used to give meaning about case problems;
4. Incompetence of students in implementing principles at a problem.

In order to be able to solve mathematical problems well, O' Neil (1978: 39) gave four main steps, namely: (1) the capability of understanding the contexts or verbal problems; (2) the capability of constructing relevant mathematical models; (3) the capability of

modification or manipulation; and (4) the capability of drawing a conclusion contextually.

It could be summarized that in solving mathematical case problems, it is necessary for students to: (1) search what is given in the case problem; (2) search what is asked in the story problem; and (3) choose suitable operations followed by writing mathematical sentences.

A situation could be a problem for a person if he realizes that situation and acknowledges that the situation needs action, while he cannot find out the problem about that situation (Bell, 1978: 310). Hudoyo (1983:2) stated that a question is called a problem if a person does not have a certain regulation that could be used soon to find out the answer needed. Russeffendi (1991: 336) stated that a situation could make a good problem for a person if that situation could be identified and that a person is eager to solve it, whether he could find the answer of the problem or not.

In the teaching-learning of problem solving approach, students get experience in using knowledge and skills possessed to apply at the problem solving which is not commonly a routine. Students would be skillful in finding patterns, communicating mathematics, and generalizing other linked skills. This approach is considered to be difficult either for students or teachers, because it needs high ability. (Sutawidjaja: 1998:2). The students' previous problem solving experience, cognitive development, motivation and skills at mathematics is a main factor influencing problem solving strategies. The problem solving procedure consists of four steps; namely: understanding the problem, planning how to solve the problem, carrying out the plan, and checking all the steps (Polya: 1981). Based on the research background and literature review, the research hypothesis can be formulated as follows "The teaching-learning of mathematical case problems through problem solving could improve elementary school students' achievement".

2. Method

This study tried to describe the teaching learning process of mathematical case problems. To express the teaching–learning process, the researcher collected data in the form of phenomena and verbal language (words, sentences, statements), and enough quantitative data that were the result of the action post test to support the qualitative data. The data were analyzed by interpretative inductive and qualitative techniques. The researcher participated directly and worked collaboratively with the class teacher who carried out the teaching-learning activities in the classroom. The researcher developed the research planning and media together with the class teacher.

When the teaching-learning was being carried out, the researcher and the headmaster observed the teaching-learning process. The researcher was the main instrument and also the data analyzer as well as the decision maker whether the teaching–learning process had been successful or not. That was why the researcher used the qualitative approach. The research type carried out was classroom action research. The Kota Gede V elementary school was the place where the classroom action research was carried out. The researcher chose that elementary school because that school faced difficulties with the teaching-learning of mathematical case problems, especially in the fifth grade.

The type of data collected was qualitative data which were the result of observation about the running of the teaching-learning process, the teacher's teaching method, the students' response about the teaching-learning, the students' activity and how the students work with the available student

work sheets. Besides, the data resulted from the interview with students and teachers were also collected. To complete and support the data, quantitative data from the test results of before and after the action were also added.

The researcher and the headmaster observed the teaching–learning from either the teacher's side or from the students' side. The observation looked at how the teacher delivered the knowledge, how the teacher managed the teaching-learning, and how the students' reaction toward the teaching-learning process. The observation format was used to observe the teacher and the students. An interview was carried out in order to get a deep drawing about students' understanding, difficulties faced by students, and students' responses about the teaching-learning of mathematical word problems by the problem solving approach. The teacher who carried out the teaching-learning, besides being observed in how to manage and deliver the material during the teaching-learning, was also asked about his opinions about the teaching-learning mathematical case problems by problem solving approach.

To get qualitative data about the students' ability in solving case problems, a test was carried out. The test was carried out before and after the teaching-learning action to know whether there was a significant difference or not, before and after the teaching-learning was carried out.

The data were carefully collected by observation, interview, and field notes. They were analyzed by the method stated by (Miles and Huberman, 1992:17). The method contains that the analysis method consists of: (1) data reduction, (2) data presentation, and (3) conclusion. Qualitative data were analyzed by descriptive qualitative techniques.

The validity of the data was carried out by checking and rechecking between observer, the researcher, and the teacher who carried out the teaching-learning and a triangulation technique. Discussion, information exchange, and opinions were carried out among teachers, observers, and the headmaster to draw relevance of data of the research result gained.

The steps and design of the study was based on the main principles stated by Kemmis and Taggart (1998:13). The procedure and research steps followed the four steps as a cycle of planning, action, observation, and reflection, and followed by re-planning if it was needed. The planning was begun by carrying out the discussion with the headmaster and class-teacher to discuss the time stated and the media needed to carry out the classroom action research. The teacher who carried out the research had to understand the teaching-learning steps of mathematical case problems by the problem solving approach. The action plan was corrected in order that the action could be carried out correctly in accordance with the research aim; that was improving understanding and skills in solving problems. The teacher delivered that problem solving strategies, among them, as follows: by drawing tables, working backwards, and guessing (trial and error). The problems, then, was solved by using the following steps: (a) understanding the problem, (b) constructing the plan, (c) carrying out the plan and (d) looking back /checking back). Before the students understood the case problems, they had to know what were known, what was given, and what was asked in the case.

The carrying out of the plan intended was how the teacher performed the steps of the teaching-learning problem solving strategy, how the teacher managed the class, and how the teacher responded to the students' questions. If a student had really understood the steps of a problem solving, the teacher acted as a facilitator, guide, and counselor. The acted monitoring and observation were carried out by the teacher and the headmaster when the teaching-

learning was running with the expectation that the result would be in accordance with the plan and it would result in the wanted change. Besides, monitoring and observation were used to collect qualitative data about the action process, so that probability and obstacles could be identified to make the next action better. The technique was completed by field notes, structured interview, and documentation.

Qualitative data were collected during monitoring. Qualitative interpretation and discussion to get agreement and conclusion as the material of next action plan was carried out after that action. Among the materials were students' appreciation, students' reactions, and students' attitudes toward their ability about teaching-learning process and result. Class management was also discussed in accordance with the teaching learning process. The quantitative data that were the data about students' achievement were collected by the test instrument after the teaching-learning was carried out to complete and support the qualitative data.

The reflection was carried out beginning with the problem finding, action plan and carrying out the action. The problem that appeared in the field was used as a starting point to carry out the re-planning, to revise, and make perfect of the next plan whether it was necessary or not to make the next planning. It depended on the qualitative data and quantitative data as well as the criterion stated. If the qualitative data, as the student achievement test had been gained and the mean score had been 70, then the classroom action research was ended.

3. Findings and Disscussion

In the previous step, the researcher carried out the pre-test with the material of mathematical story problems; and only up to understanding what is given and what is asked in the case, how the mathematical sentence is stated, and how the algorithm and mathematical sentence are used to answer the questions. But there were also special problems which had special ways of solving and finishing like working backwards, guessing and checking, drawing as an illustration, and table construction. All the 32 students were recorded, came, and joined the pre-test, and the achievement test gained the mean score: 12,9 in the range score between 0 - 27 or the mean score was 41 in the score range of 0 - 100. Meanwhile, the minimum score was 5 and the maximum score was 27 in the score range between 0 - 27.

From the pre-test result, it could be shown that the mastery of how to solve the mathematical case problems was low. Most students were still incorrect in solving and doing the problems by the strategy of working backwards, by using tables, by and drawing illustration.

The next step was a negotiation with the class teacher about how to construct action implementation and make a schedule, where the beginning of the study was marked. In the beginning, the teacher who carried out the program was asked to discuss the problem solving of mathematical story problems. Before students solved or finished the problems, they had to understand case problems, at last they understood what was given and what was asked, constructing mathematical sentences and solving as well as finishing the mathematical sentences constructed. These were algorithms and at last correct answers could be attained. If the problem was complicated, it would use steps that had been used by Polya, namely, understanding the problem, constructing the plan, carrying out the plan, and looking back. And there was a problem approach with certain types of problems. Besides using unroutine ways, alternative ways could be drawings, guessing, and checking techniques, using tables and working backwards. At the

last discussion there was also agreement whether the action had been successful or not, when the research ended. At the first cycle of the teaching-learning action, it was expected to be able to make the students' understand mathematical case problems; namely what was given, what was asked, constructing mathematical sentence, and finishing with the correct algorithm. Besides, there was also an added action about the teaching learning type that could be solved by using guesses and checks, making tables, and working backwards. During the time when the action was carried out, monitoring was also done by the researcher and primary teacher students who did practice teaching at that school. The first cycle consisted of two stages. Those were what was given, and what was asked in the case. How to construct mathematical sentence and how to answer or finishing the mathematical sentence correctly were still difficult for the students.

At the first cycle, the action could not cover all the material prepared, so it had to be continued to the next cycle, whereas at the second cycle, the action could cover all material about mathematical case problems, and the way how to solve. The way how to solve could be by drawing, making tables, guessing and checking, and working backwards. After the teacher realized that students were able to finish solving the mathematical case problems, he directly delivered an individual test, and it could cover all the material discussed. The first cycle consisted of two meetings.

In the result of the post test after the first cycle, the mean score was 61,25 in the range score of 0 - 100 or the mean score was 16,55, with minimum score of 9 and maximum score of 27 in the range score of 0 - 27. By looking at the post test result of the action, it could be shown that there was no significant difference between the previous test result and the test result after the action was carried out. The students' learning achievement was still low. The problem that had not usually been able to be solved by the students was working backwards; the problem could be solved by making variables and linear equations in finishing the problems. Besides, the problems by guessing and checking in solving the problems and by working backwards had not been effective; the class management had not been good and the teacher had not given necessary motivation to the students. The students' responses had not been positive and it seemed that the students did not know the aim of the teaching and learning, because it was different from the usual teaching and learning.

Based on those facts, the researcher, teachers, and the practice students decided to make the next planning for the second cycle. The second cycle was intended to respect and solve smoothly difficult problems. The next week on the same day and hour, the second cycle was carried out. The teaching and learning was relatively the same as in the first cycle, and it was only concentrated on the material that could not be solved correctly by the students and by different strategy. The Polya's steps in solving the problems began to be implemented. Besides the students had to understand what was given and what was asked on every problems, they were also guided to construct planning, carry out the plan and look for the result backwards.

The action of the second cycle was an effort to make students be familiar with certain strategy in solving mathematical case problems. Because the teaching and learning steps went well and all the material planned had been delivered to the students, the second cycle was ended. The second cycle just consisted of one meeting. The teacher directly delivered the post test. The problems had relatively the same difficulty degree as the first cycle. The result of the test had a mean score of 19.81 with the lowest score 10 and the highest score 20 in the score range

between 0 - 27. In the range of 0 - 100, the mean score was 73.8 Most of students had been able to solve the problems by using tables and by working backwards.

The observation results carried out by observers were: (1) Most students had discussed seriously about mathematical case problems delivered by the teacher, and not about other cases: (2) Every member of the group seemed to be enthusiastic in participating in the discussion. (3). Students took and gave experience in solving the problems delivered by the teachers,(4) The teacher had already mastered the problem material discussed with relevant examples, (5); The teacher had really carried out the teaching and learning with problem solving approach contextually. (6). The teacher's performance was really professional and gave chances to students to express their own ideas. (7) The complete evaluation comprising process, product, and performance was also carried out.

Form the post test, the observation result of the teaching and learning process, and interview, results of discussion and agreement between the researcher and observers, it could be concluded that: (1) The students had already understood the solving approach of mathematical case problems by using drawings, tables, working backwards or by guessing and checking; (2) Almost all of the students had been able to feel the use of discussion and solving problems of mathematical case problems. (3) All the steps of the teaching and learning by the problem solving approach had already been fully applied in the teaching and learning. (4) The post test result showed that the students' achievement had been above the criterion stated.

Based on the facts and the discussion result among the researcher, observers and practice students, it could be concluded that it was not necessary any more to continue to the next cycle. In other words, the action research could be ended.

From the previous test, it could be found that almost all of the students had not been able to understand problem solving strategy even in the simple form like understanding the problem and what was asked in the problem. Moreover, problems which involved making tables, drawings, and working backwards in solving them, had not been fully understood by the students. It was probably because the teaching and learning process they underwent was just the conventional approach and the material was not connected with contextual problems. It was in accordance with Ausebel's statement (Bell, 1978; 13) that learning with only receiving information and without activating students' thought would not come to a discovery.

At the first cycle the step had not been in accordance with the planning, because the students had not understood the material. Special strategies in solving certain problems, the understanding about case problems (what was given and what was asked) had not been mastered well. The discussion was still dominated by those who had higher capability than others. The students had not been motivated well in solving mathematical case problems. If students were motivated well, they would concentrate their attention to relevant aspects of the teaching-learning (Dahar, 1996: 174). Most of the students had not understood the special strategies in finishing problems in accordance with their types. Almost all of the students had understood and even had been able to construct mathematical sentences after they had understood the problem in the sentences. Those might be caused by the fact that they had been familiar with solving case problems in the previous years; in accordance with the opinion stated by Orton (1992: 90), if the students had been familiar with solving and finishing case problems,

they could not understand what was given and what was asked at every problem as usual.

At the first cycle, from the post test result it could be understood that most of the students had not been able to solve mathematical case problems using the strategy of working backwards, drawings, using tables, and guessing and checking. Meanwhile, at the second cycle, the running of the action had been in accordance with the plan and expectation. That was because the material delivered was relatively the same as the first cycle and the students had understood how to solve mathematical case problems. Besides, mathematical case problems that were considered to be difficult were especially those that should be solved by working backwards strategy, drawings, and using tables had been mastered by students; those problems had connection with real daily life. Group discussion was one of the characteristics of the teaching-learning of problem solving had already run lively well. This condition was consistent with Vygotsky's statement (Nur: 1998:7) that the elements of cognitive changes toward understanding was influenced by learning models of the way of thinking and there were taking and gaving knowledge and experience in forming new ideas.

To make the teaching–learning mathematical case problems through problem solving more interesting, it was begun with realistic illustration followed by drawings (*semi-abstract)* and then formal abstracts. When the teacher expressed the concept of a cone, she showed the cone made of paper, then she drew it on a white board and after most students understood, she just wrote down 'cone'. This is in accordance with Bruner's idea (Orton, 1992: 40) of understanding the concept through steps of enactive, iconic, and symbolic, for elementary school students. At that second cycle, the discussion situation was really alive and there were taking and giving of knowledge as well as experience. This is the same as Joyce and Weil's idea (2006: 81) that formalization mathematical concept was the development of process which was the same as an individual and social activity.

4. Conclusion

From the data and research findings described earlier, the conclusion can be drawn as follows.

The teaching–learning of mathematical case problems by using a problem solving approach could improve students' learning achievement. The score of the pre-test before the research was carried out was only 41, and at the first cycle could improve to be 61.25 and at the last cycle was 73.8 in the range score of 0 - 100. Students' understanding about problems in mathematical case problems were characterized by understanding what was given and what was asked at the case problem, so they could finish them correctly. Mathematical problems by special strategies could be finished well, because they could finish in a group discussion by the teacher's guidance.

The students' responses towards the teaching-learning were good and positive. They were enthusiastic in responding to the mistakes and finally finished them in the group discussion. They felt happy and actively participated in the discussion process. Moreover, they shared knowledge as well as experience.

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