

The Students' Ability to Solve Realistic Mathematical Problems through Polya Type Problem Solving Learning Model

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ABSTRACT

This study was done to analyze the effect of Polya type problem solving learning oriented toward realistic mathematics on the ability to solve mathematical word problems. This study belongs to an experimental research with the Posttest Only Control Group Design. The population used in this study was the students of grade 4 at Gugus VIII Sukawati Gianyarelementary schools with the total number of 138. The sample was selected through random sampling. The result of selection by lottery assigned Grade 4 students of SDN 4 SingapaduKaler to the control class and Grade 4 students of SDN 1 SingapaduKaler to the experiment class. The data were collected through an essay test that had been validated. The data that had been collected were analyzed through a difference test (t-test). Based on the result of data analysis it can be concluded that the use of Polya type problem solving teaching model oriented toward realistic mathematics gave a positive effect to the ability to solve word problems among the Grade 4 students in Gugus VIII Sukawati Gianyar.

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1. INTRODUCTION

Mathematics is a thinking pattern, a pattern which organizes logical verification, a structured knowledge which contains properties and theories and is built deductively based on undefined elements, axioms, properties or theories whose truths have been verified [1]. Elementary Mathematics is a subject which functions to develop the ability to communicated by using numbers and symbols and the sharpness of reasoning which can clarify and help in solving problems in everyday life [2]. One of the objectives of Mathematics in KTSP (School Based Curriculum) is for the students to possess the ability to solve problems which comprises the ability to understand problems, to design a mathematical model, to complete a model and to interpret a solution that has been found [3]. Mathematics can provide students with the organization of reasoning and the development of character . In addition, mathematics is an important knowledge to be learned by people of all ages and in daily life mathematics is frequently used and needed. Mathematics has the use of building critical , systematical, logical, creative patterns and ability to work with others [2, 4]. In line with this view, Sujono states that the main values contained in mathematics are practicality, discipline, and cultural values [5]. This statement is supported by the Regulation of the Minister of the National Education no 23 of 2006 that states that Mathematics needs to be given to all students starting from elementary school to provide them with the ability to think logically, analytically, systematically, creatively, and the ability to work with others.

To achieve that goal, the application of mathematical concepts in teaching are given in exercises to solve problems in the form of word problems. Word problems are problems which are stated in the form of meaningful and easy to understand sentences [6–8]. Word problems can be presented in oral and writing forms, a written word problem is a sentence which illustrates an activity in daily life [9]. Word problems are useful for applying the students' previous knowledge. The solution to a word problem forms a problem-solving activity. It is a process that contains correct and logical steps to obtain a solution [10, 11]. The solving of a word problem, is not only the obtaining of a result in the form of an answer to what is asked, but the more important thing is the students have to know and understand the thinking process or the steps to get the answer.

The report on the *Third International Mathematics and Science Study* (TIMSS) in 2015 stated that Indonesia's mathematical ability is ranked 45th out of 49 countries [12]. Specifically, in the report, it is explained that the average Indonesian children have knowledge of mathematics, but they cannot solve the problems that require the acquisition and problem solving. It was strengthened by the report of Programme for International Student Assessment (PISA) in 2015 which published the result of the assessment for students' mathematical and science literacy ability in Indonesia which put Indonesia in the 62nd place from 70 countries assessed by PISA. As a result of PISA's defining ability of problem solving in the real-life context and the dimension that was developed by PISA, the students in Indonesia have a far-reaching outlook set by PISA [13].

The today's phenomena show that there are many students who have relatively high grades but are less able to apply the results that they obtained either in the form of skill, attitude or knowledge in a particular situation, especially in daily life. In general, when a student faces a problem whose solution uses Mathematical learning material that he or she learned, the student still faces difficulties and even has not been able to solve it, similarly some students still face a problem in solving a word mathematical problem [14].

The weakness of problem solving is also made from the results of observations. The result of the documents analysis of the Gugus VIII Sukawati students' answers shows that there were some weaknesses of the students in solving word problems, namely: 1) the students did not understand the problems; 2) the students did not do any problem identification and planning in problem solving; and 3) the students did not recheck all steps that they had followed. Generally, the students faced problems in understanding the contents and in making mathematical models from the word problems given to them. When they were given word problems with contextual or real problems only a small number of them could solve the problems directly while others only waited for their friends' answers or the teacher's explanation and then copied the answers. The result of observation of the Mathematics teaching process in Gugus VIII Sukawati shows that the students' low ability and activity in the teaching process, especially in solving word problems was caused by various factors, namely, the students could not compute, the students had difficulties in solving problems as shown in the number of errors they made in answering problems or working on the problems, and they were still shy in communicating their ideas and still hesitated in expressing the problems when they faced mathematical problems. When there was a problem presented in another form (which was not the same as the example given) the students were confused about how to solve it. This shows that their reasoning in learning was still low. These were the factors that caused the low learning achievement of the students in Mathematics, especially in solving word problems as indicated by the result of observation made at SD No. 1 Singapadu Kaler in January 2014. The minimum learning mastery level criterion in the school was 6,5. The number of the fourth grade students who got grades below the minimum learning mastery level was 71%.

To answer the problems in teaching as explained above, especially in relation to the ability to solve a word problem, an innovative effort needs to be made. Here teacher's creativity is needed in reforming the teaching. The main role of the teacher in teaching is to design, to manage, to evaluate and to provide a follow-up activity for the teaching activities [15]. Teachers as the foremost actors of education who are directly involved in teaching are required to make an improvement in the teaching process which is expected to enhance the students' learning achievement. The improvement in the teaching process can be made by using innovative approaches, strategies, models, or methods. This is confirmed by [16] who says that teaching is a way used by the teacher, in his or her function as a means to achieve learning objectives. Teaching method is more procedural in character which contains particular stages. Learning objective is the realization of efficiency and effectiveness in learning activities done by the students. [17] define teaching model as a conceptual framework used as the guideline in teaching. Hence, teaching model is a conceptual framework which describes a systematic procedure in organizing learning experiences to achieve a

learning objective. After objective observations, interviews, and reflections were done on the teaching process in Gugus VIII Sukawati, it was found that the teaching process so far (1) had not given an emphasis on the students' ability to solve problems (problem posing and problem solving), (2) tended to orient toward a cognitive strategy to achieve a learning objective, and (3) had not been oriented toward the development of creativity and productivity in thinking (creative and productive thinking) to achieve a deep

understanding. Although the method so far has given an important role to student's activity, for example through the formation of learning groups (cooperative learning), it turned out that its effect on the students' problem solving ability and mathematical reasoning, and mathematical communication had not been felt. This of course had a bad effect on the achievement of the students' understanding of the teaching materials, which in the end caused the low students' learning achievement.

Although it had been realized that the students were very heterogeneous, they were different in aptitude, prior ability intelligence, motivation, speed in learning and in other aspects, the conventional teaching system which has been so far implemented does not pay enough attention on the differences. Conventional teaching model (the model of teaching which is usually used in teaching) does not conform to the Regulation of the Minister of National Education of the Republic of Indonesia No. 41 in 2007. This regulation is a regulation about process standard for elementary and secondary schools and explains that the teaching process is done interactively, inspiratively, joyfully, in a challenging manner, motivating students to participate actively, and giving enough room for initiative, creativity, independence, according to aptitude, interest, and physical and psychological development of the students. So, it is clear that the regulation instructs that teaching should be done with the focus on the students by considering their environments harmoniously. This idea finds support from [18] who state that teaching should be defined as a set of events which are designed to produce learning. Furthermore, [19] state that teaching is an active and reflective process of thinking, action and experience to create new knowledge and to achieve other ends. Teaching can also be defined as an activity of selecting, determining, and developing methods for achieving desired teaching objectives [20].

One teaching model which can be used to improve the ability to solve word problems is Polya type problem solving model or some people call it SSCS (Search, Solve, Create, and Share). According to Pizzini [21] Polya type problem solving model is one of the innovative models which is very appropriate to be used in teaching Mathematics since it is oriented toward problem solving. Polya type problem solving model consists of four steps of problem solving, i.e., identifying a problem (search), planning to solve the problem (solve), conducting problem solution (create), and socializing the problem solving that has been done (share).

Empirically, SSCS teaching model has been implemented and found that a visual media aided SSCS had a positive effect on the learning achievement of the fourth grade students in the even semester in the academic year 2012/2013 at the Gugus VII elementary schools of Busungbiu District, Buleleng Regency [22]. They explained that the positive effect was produced by the use of the SSCS teaching model which was designed to help the students in developing critical thinking skill and improving the students' understanding of concepts. Warmini also explained that the SSCS teaching model is a teaching model which is oriented toward problem solving, so the students in this model are asked to be directly involved in determining the solution to the problem which is then continued with problem solving. The students become active and engage more deeply in the teaching process.

This is also supported by the result of library research which states that the advantage of the SSCS model is that the students can learn more meaningfully, since the students are directly involved in the discovery of concepts. In addition, the students will become more active since they are trained to be able to formulate a problem, design a solution, formulate results and communicate the results that they get [23]. For supporting the implementation of the SSCS teaching model in order that it can work more effectively, the teacher can use teaching media such as module, student's worksheet, handout, etc. The SSCS teaching model is effective since it is student centred which gives more chance to the students as the centre of learning. In the teaching with SSCS teaching model the students do not only use the existing knowledge, but pay more attention to the process of knowledge acquisition. By focusing on process, the students are expected not only to learn knowledge, but to know it more deeply so that the knowledge that they have acquired is always retained and remembered by the students. Hence, the students' understanding of the concepts can be improved.

Based on the above explanation, it can be seen clearly that Polya type problem solving teaching model and conventional teaching model have different characteristics. The different characteristics will produce consequences in the way and the result of concepts understanding and this is assumed to affect the students' learning achievement. This study tested the effect of the implementation of Polya type problem solving in the students' Mathematics learning achievement.

2. RESEARCH METHOD

This is an experimental research with Posttest Only Control Group Design since in this research it was only the posttest scores that were taken into account, in which the posttest was administered at the end of the research. Posttest Only Control Group Design research is an experimental research which compares two groups who are given different treatments, then at the end of the research a test is given using the same

instrument [24]. The population in this study was all of the fourth grade students in Gugus 8 SukawatiGianyar, in which there are seven elementary schools, namely, SDN 1 SingapaduKaler, SDN 2 SingapaduKaler, SDN 4 SingapaduKaler, SDN 5 SingapaduKaler, SDN 1 Singapadu Tengah, SDN 2 Singapadu Tengah and SDN 3 Singapadu Tengah. Based on the characteristics of the population, individual randomization could not be done, therefore, the sampling was not done by using simple random sampling, but what was randomized was the classes. The selection of sample in this study was not based on individuals, since there was no attempt to change classes which had been formed before the study was done. Classes were selected in tact without any interference from the researchers, the possibility of the effect from the the condition where the subjects knew that they were involved in an experiment could be reduced so that this study can actually describe the effect of the treatment given. The result of the lottery indicated that the fourth grade students of SDN 4 Singapadu Kaler was assigned into the control group and the fourth grade students of SDN 1 Singapadukaler into the experiment group. the class experiment was treated in form of problem base learning in Polya type , while the control group was not given some treatments means that the learning process was done conventionally.

The instrument used to collect data on the ability to solve mathematical word problems was an essay test in the form of word problems which had been validated before. An essay test requires the student's ability to organize, interpret, relate, the concepts that have been already possessed [25]. The data analysis technique in this study was t-test by meeting some assumptions as prerequisite tests. The prerequisite tests in this study were data normality test and varinace homogeneity test. To understand whether the distribution of the data of the students' mathematics learning achievement in each group had a normal distribution or not, Chi-Square analysis was used. The criterion for the testing was if $X^2_{obs} < X^2_{(1-\alpha)(k-3)}$ H_0 was accepted it means that the data had a normal distribution. While homogeneity testing was done to show that the difference that occurred in the hypothesis testing was actually due to an inter-group difference, not as the effect of differences within the group. Homogeity testing of the data was done by using avley's ANOVA. The testing criterion was if $F_{obs} < F_{c.v.}$, then the data were homogeneous, while the degreee of freedom was $n-1$.

The statistical analysis used to test the hypothesis of this study the mean difference testing (t-test) of non-correlated groups. The significance testing was if $t_{obs} < t_{c.v.}$, then H_0 was accepted (failed to be rejected) and H_a was rejected, otherwise, if $t_{obs} \geq t_{c.v.}$, then H_0 was rejected and H_a was accepted. The testing was done at the the 5% significance level ($\alpha=0,05$) with $df = n1+ n2-2$.

3. RESULTS AND ANALYSIS

3.1. Data Distribution of Research Results

After doing this research the data on the students' scores were obtained based on the posttest which was administered at the fourth grades of SDN 1 Singapadu Kaler and SDN 4 Singapadu Kaler in the standard of competence of using fraction in problem solving. The statistical computation result of the ability to solve word problems for the experiment group and control group can be seen in Table 1.

Table1. Table of data doistribution in the ability to solve word problems

Statistical Variation	Experiment Group	Control Group
Mean	82	63
Standard Deviation	6.57	8.8
Number of Subjects	21	18

3.2. Data Normality Testing

Based on Normal curve, interval class, observation frequency, (f_o) and empirical frequency (f_e) of the data of the posttest scores for the ability to solve Mathematical word problems of the fourth grade of SDN 1 Singapadu Kaler as the experiment class, is 2.9915 was obtained and at the 5% level of significance and degree of freedom ($df = 5$) $X^2_{c.v.} = X^2_{(0.05;5)} = 11.07$ was obtained, since $X^2_{c.v.} > X^2_{obs}$, then H_0 was accepted. This means that the distribution of the data of Mathematics posttest scores of the fourth grade students of IV SDN 1 Singapadu Kaler in the experimental group had a normal distribution.

While for the control group or the fourth grade students of SDN 4 Singapadu Kaler, the Mathematics posttest scores was 1.8880 and at the 5% level of significance ($\alpha = 0.05$) and degree of freedom ($df = 5$), $X^2_{c.v.} = X^2_{(0.05;5)} = 11.07$ was obtained, since $X^2_{c.v.} > X^2_{obs}$, then H_0 was accepted. This means that the distribution of the data of the Mathematics posttest scores of the fourth grade students of SDN 4 Singapadu Kaler or control class had a normal distribution.

3.3. Variance Homogeneity Testing

From the computation $F_{obs.}$ of 1.63 was obtained while $F_{c.v.}$ at the 5% level of significance with df of the numerator = 17 and the df of the denominator = 20 was 2.12. This means that $F_{obs.} < F_{c.v.}$, thus H_0 was accepted. This means that the variance of the data was homogeneous.

3.4. Hypothesis Testing

The data that were successfully collected were analyzed by inferential statistics while t-test was used for testing the hypothesis. The results of the t- test analysis can be seen in Table 2.

Table2. Result of Hypothesis Testing at the 5% level of Significance and df = 37

Topic	Treatment Given	Mean Score	Value of $t_{obs.}$	Value of $t_{c.v.}$	Alternative Hypothesis Hipotesis
Using fraction in solving problems	Implementation of Problem Solving Model	82	7.917	2.021	Accepted
	Conventioan Teaching Model	63			

Based on the result of data analysis it was found that $t_{obs.} = 7.917$. Using the 5% level of significance 5% and df = 37 it was obtained that the limit for the null hypothesis rejection = 2.021. It means that $t_{obs.} > t_{c.v.}$, thus the null hypothesis was rejected and the alternative hypothesis was accepted. It can interpreted that there is a significant difference in the ability to solve Mathematical word problems between the implementation of Polya type problem solving and conventional teaching to the fourht grade students of elemetary studhents in Gugus 8 Sukawati Gianyar.

3.5. Discussion

Based on the result of t- test analysis it was found that $t_{obs.} > t_{c.v.}$, which means that the hypothesis which says that there is a significant difference in the ability to solve mathematical word problems between the students taught through Polya type problem solving teaching model and those taught through conventional teaching model to the fourth students of elementary schools in Gugus 8 Sukawati Gianyar at the 0.05 level of significance is accepted. The difference shows that Poilya type problem solving teaching model gives a positive effect on the ability to solve mathematical word problems. The students taught by using Polya type problem solving teaching model got higher scores in the standard competence of using fraction in problem solving than those taught by using conventional teaching method.

This was caused by the full participation of the students in the learning process in the classroom, in which the teachers played the role as facilitators who directed and gave guidances to the students on how they had to think and do correctly accordding to the context of the real lifethat they experienced.

This was proven by the mean scores obtained at the end of the treatments, i.e., 63 for the controled variable (conventional teaching model) and 82 for experimented variable (Polya type problem-solving teaching model). Besides, from the results of observation and interview done with some of the students in the control class and experiment class, in the experiment class the students were more active and more enthusiastic in the teaching and learning process, no students were sleepy or daydreaming when the teaching of the topic started.

This was very different from what was shown by the control class, most of the students looked very tired and sleepy when the teacher taught the topic of the lesson. Most of them looked confused when the researchers tried to interview them asking them the same questions as those given to the experiment class. The ability to relate the topic and the daily life was too low. Since they were not prepared for that, they only tried to learn names by rote, the train of thoughts presented in the textbook, and to repeat them again at home. This activity was rather boring to them, as if Mathematics were not more than a science that had to be learned by rote without understanding the purpose the teacher taught it to them. This supports that hypothesis which says that there is a difference in ability to solve mathematical word problems in the students who were taught by Problem Solving model and those whoe where taught by conventional teacing model.

4. CONCLUSION

In the light of the result of the hypothesis testing and discussion on the data obtained it can be concluded that there is a significant difference in the ability to solve mathematical word problems between the effect of the the implementation of Polya type problem solving model and that of the implementation of conventional model The teaching which implemented Polya type problem solving model gave a better result

compared to that which implemented conventional teaching model. This means that there is a positive effect of Polya type problem solving teaching model on the students' ability to solve mathematical word problems.

In the light of the result, it can be suggested to the teachers of Mathematics that they should try to use teaching models which are related to the students' daily context in order that the teaching and learning activities can take place effectively and efficiently. One of the teaching models which can be implemented is Polya type problem solving teaching model. To the other researchers it is suggested that they should be more innovative in finding a teaching method to be used in the effort to improve the students' learning achievement and the quality of education in Indonesia.

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