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Effects of Creative Problem Solving Learning Model on Mathematical Problem Solving Skills of Senior High School Students

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Abstract: *This research aims to know the effects of creative problem solving learning model on the mathematical problem solving ability of students in senior high school. The research method was experimental research with quasi-experimental design. Independent variables used in this study were creative problem solving learning model and direct learning model. The dependent variable used was the mathematical problem solving ability. The sampling was taken by random sampling technique with a sample of 78 consisting of 40 students of XI IPA 1 (11th grade class 1 of science) as the experimental group and 38 students of XI IPA 2 (11th grade class 2 of science) as the control group. The data collection used mathematical problem solving ability test while the analysis used t test. The results show that the value of* t_{count} *(3.43) >* t_{table} *(1.665), it means that* H_0 *is rejected or there are differences in mathematical problem solving ability of students who learn using creative problem solving learning model and direct learning model. The difference is the mathematical problem solving ability of students that learn using creative problem solving learning model which is higher than the students that learn using direct learning model. It means that there are effects of creative problem solving learning model on mathematical problem solving ability of students.*

Keywords*: Learning model, creative problem solving learning model, direct learning model, mathematical problem solving ability*

I. Introduction

Mathematics learning is presented to the students since elementary to higher education level. Mathematics is a pattern of thinking and organizing as well as logical proof about shape, structure, number, and concept related to everyday life. In accordance with one educational goal to actualize the individual ability, then one of the existing abilities in mathematics education is a mathematical problem solving ability.

Mathematical problem solving ability is one of abilities needs by the students, for problem solving gives a great benefit to the students to see the relevance of math with other subjects as well as in real life. Students are said to be able to solve mathematical problems if they can understand, choose the right strategy, and then implement them in problem solving. Mathematical problem solving ability may trigger to a better mathematics learning outcome. Mathematical problem solving skills may help in solving both problems in other subjects and in everyday life, and therefore required the teacher creativity in teaching.

Teachers become the main focus, because they directly affect, assess and develop student ability to be a smart, skillful and moral human. Therefore, the efforts to improve student learning outcome cannot be separated from efforts of teacher ability to teach and use the models in the mathematics learning. Various learning models have been applied by the math teachers in schools for communicating the concept of the subject material, but the use of learning models are not necessarily creating a good learning outcome.

Based on the results of preliminary observations at SMAN 6 Jambi (Public Senior High School 8, Jambi city), the facts provided in respect of the poor ability of mathematical problem solving, it can be seen from the answers of students who answer the following questions: *To get an A, one must have an average score of test at least 80. Zaki's scores from the 1st, 2nd, 3rd, and 4th test are 90, 75, 80, 70 respectively. Determine the minimum score that he should get on the 5th test so that Zaki may get A!* From the 32 students of class X who answered correctly was only as much as 21.9%, less precise answer was 50% and did not answer was 28.1% and the answers of students above show an error in identifying the elements that exist on the problem, therefore the solving problem becomes less precise. It is because there is a lack of understanding of students in solving the problem in the question.

From the observation, it also well known that the math teachers of SMAN 6 Jambi use a direct learning model in the teaching process. Direct learning model is a learning model that refers to the way of teaching in which the teachers are actively involved in carrying the content of the lesson to the students and teach it directly to the entire class. Teachers explain the material from the beginning to the end of the lesson and accompanied by examples, then the students are given several questions for practice. This causes the less student role in the learning process because the learning that takes place is a teacher-centered and one-way communication so it

makes the students less motivated, more listening and taking notes. The lack of mathematical problem solving ability of the students at SMAN 6 Jambi in learning mathematics cannot be left alone, as it can adversely affect the students themselves. To resolve the problem, it will require an effort to make the learning environment more interesting and fun, one of which is by a creative problem solving learning model. Creative problem solving learning model is where the teachers direct the creative problem solving and also provide the subject material or topic of discussion that may stimulate the students to think creatively in solving problems. The research problem is: Is there any effects of the creative problem solving learning model on the problem solving ability of the students at SMAN 6 Jambi? The results of this study are expected to add the repertoire of science, especially in mathematics associated with learning models and mathematical problem solving ability.

II. Theoretical Framework

In this study, first we need to understand the theories of mathematical problem solving ability and problem solving learning model.

1. Mathematical Problem Solving Ability

According to Fauzan (2011), problem solving ability is the main outcome from a mathematics learning process because problem solving is said to be the learning target. In problem-solving skills, the students should be able to solve mathematical problems in the textbook or those given by the teachers which also related in real life. Therefore, it is necessary to design problems that can help students to make connections between mathematics and their lives as well as with other subject. Furthermore, Fauzan (2011) identifies three things of the teacher responsibility when developing the mathematical problem solving ability, namely: (1) help the learners to develop a collection of problem solving strategies; (2) guide the learners to master mathematical concepts, techniques, numeracy skills to solve problems; (3) provide an opportunity for the learners to use those strategies in a variety of broader circumstances. According to Polya in Ahmad Fauzan, in solving the problem, there are four steps to be taken, namely: (1) understand the problem; (2) plan the problem solving; (3) solve the problem according to plan; (4) re-examine the results obtained. This problem solving stage related to the indicators of mathematical problem solving capabilities described by Fauzan (2011). Below, there are descriptions of the indicators of mathematical problem solving ability based on the problem solving stages by Polya, described in Table 2.

Table 1. Indicators of Mathematical Problem Solving Ability

Problem Solving Stage	**Indicator**
Understanding the problem	Identify the elements that are known, asked, and the adequacy of the necessary elements
Plan the problem solving	Formulate a mathematical problem or to develop a mathematical model
Solve the problem according to plan	Implement strategies to solve the problem (similar and new problems) inside or outside the mathematics
Re-examine the results obtained	Explain or interpret the results using mathematical problems significantly

Source: Ahmad Fauzan (2011).

Table 2. Assessment Rubric Mathematical Problem Solving Ability

Assessment Aspects	**Score**				
	0	1	2	3	4
Identify the elements that are known, asked, and the adequacy of the necessary elements	No answer	Wrong in identifying the elements in the problem, so the problem is not complete	Wrong in identifying the elements in the problem, so most of them misunderstand the problem	Wrong in identifying the elements in the problem, so a few of them misunderstand the problem	Understand the problems and concepts completely
Formulate the mathematical problems	No answer	Wrong in using a formula to solve the problem,	Most procedures are correct, but still make mistakes	Make procedure correctly with a small procedural error	Proper solving procedures, without error
Apply problem solving strategies	No answer	Wrong in writing the solution of a problem	Write the solution of a problem in a systematic manner, but not correct	Write the solution of a problem correctly, but incomplete	Application of problem solving strategies is correct and systematic
Explain or interpret the results using mathematical problems significantly	No answer	Wrong in making a conclusion because the answer to the question is wrong	Less precise in making conclusion of problem solving	Conclude the results of the problem using mathematics significantly, but less precise	Conclude the results of the problem using mathematic significantly with correctly and appropriately

Source: Ahmad Fauzan (2011).

2. Creative Problem Solving Learning Model

Joyce, Weill and Calhoum reveal that "*Models of teaching are really models of learning. As we help student acquire information, ideas, skills, value, ways of thinking and means of expressing themseves, we are also teaching them how to learn*"(Trianto, 2012: 51-52). Learning model can help students to obtain information, idea, skill, and ways of thinking and express their ideas. It means that the learning model is the lecturer planning in helping students to obtain information, ideas and skills, how to think and express ideas and then managed in a way so that the students want to learn.

The learning model is a planning or pattern which is used as a guide in planning the learning in tutorial (Trianto, 2007: 1). This is in line with Shoimin (2014: 23) opinion that a learning model is a conceptual framework describing a systematic procedure in organizing learning experiences to achieve certain goals, and serving as a guideline for the designers of learning and teachers in planning learning activities. This means that the learning model provides a framework and direction for teachers to teach. From some of these views, it can be concluded that learning model is a conceptual framework that describes a systematic procedure for organizing a learning experience to achieve the learning objectives.

According to Shoimin (2014: 56), a creative problem solving learning model is a variation of learning by problem solving through a systematic technique for organizing creative ideas to solve a problem.

It is a learning model that focuses on teaching and problem solving skills, followed by strengthening the skills (Shoimin, 2014: 56). So in this case, when students are faced with a question, they can conduct problem solving skills to select and develop a response. Not just by memorizing and thinking, the problem solving skills also broaden the thinking process.

According to Huda (2014: 298), in applying creative problem solving learning model the teachers serve to direct the creative problem solving and also in charge to provide the subject material or topic of discussion which may stimulate students to think creatively in solving the problems. In applying the creative problem solving learning model, role of educators is more as a facilitator, motivator, and dynamist of learning, either individually or in groups.

According to Huda (2014: 298), a syntactic process of creative problem solving learning model is: (1). Objective finding is where the students are divided into groups. Students discuss the problems posed by the teachers and brainstorming a number goals or objectives that can be used for their creative work; (2) Fact finding is where the students brainstorming all the facts that may be related to those goals. Teachers register each perspective produced by students; (3) Problem finding is where the students brainstorming a variety of possible ways to further clarify a problem; (4) Idea finding is where the students' ideas of are put on the list in order to see the possibilities for a solution to the problem situation. The teachers classify which one is the potential and non-potential idea as a solution; (5) Solution finding is ideas that have the greatest potential evaluated together to generate ideas that deserve to be a solution for the problems; (6) Acceptance finding is where the students are expected to have a new way to solve problems creatively.

3. Direct Learning Model

Direct learning model is a learning model that is specifically designed to support the students' learning process associated with well-structured declarative and procedural knowledge that can be taught by a pattern of activity gradually (Shoimin, 2014: 63). This is in line with the Suprijono (2013: 46) statement who says that the direct study is also called a whole-class teaching, it refers to a teaching style where teachers are actively involved in carrying the content of lesson to the learners and teach it directly to the entire class.

In direct learning model, there are 5 very important stages. According to Suprijono (2013: 50), the syntax direct learning model is as follows:

Table 3. Syntax of Direct Learning Model

Stages	**Teacher Behavior**
Stage 1: Establishing Set Outline the objectives and prepare learners	Explain the learning objectives, background knowledge, prepare the learners to learn
Stage 2: Demonstrating Demonstrate knowledge or skills	Demonstrate the right skills, present information step by step
Stage 3: Guided Practice Guide the training	Plan and give preliminary training
Stage 4: Feed Back Check understanding and provide feedback	Check whether the learners have managed to do a good job, provide feedback.
Stage 5: Extended Practice Provide opportunities for advanced training and implementation	Prepare the opportunity to conduct advanced training, with particular attention to the implementation of more complex situations in everyday life

III. Research Methods

This study used a quantitative approach with a comparative experimental method in the form of quasi-experimental design. Independent variables used in this study were a creative problem solving learning model and direct learning model. The dependent variable used was mathematical problem solving ability. The sampling was taken by random sampling technique with total sample of 78 students consisting of 40 student of XI IPA 1 as the experimental group and 38 students of class XI IPA 2 as the control group. The data collection technique used the same essay test on mathematical problem solving ability in the two classes. The instruments were developed by test outline and through the stages of expert validation and empirical validation by conducting tests to see the validity, reliability, difficulty level and distinguishing features. The analysis used was t test. Before the data analysis, the prerequisite test of normality test (tested by chi square) and homogeneity (tested by F) shall be conducted first.

IV. Results And Discussion

1. Results

It is presented the results of the student posttest on mathematical problem solving ability in the experimental class and control class in Table 4 as follows:

Table 4. Results of the mathematical problem solving ability

Statistics	Experimental Class	Control Class
Sample Size	40	38
Mean	70.13	62.42
Highest Score	87	80
Lowest Score	53	43
Standard Deviation	9.134852	10.4069
Variance	83.44551	108.3044

a. Normality Test

This normality test has criteria that the samples normally distributed if the result obtained is χ^2count <χ^2table with significance level $\alpha = 0.05$. The result of normality test calculation using chi square test is on Table 5.

Table 5. Normality Test of Sample Class

Sample Class	N	χ^2count	χ^2table	Testing Criteria	Description
Experimental	40	4.8	7.81	χ^2count ≤ χ^2table	Normal
Control	38	4.51	7.81		

In Table 5, it shows that the second grade sample has a value smaller than χ2table χ2count then H0 is accepted, so it can be concluded that the experimental class and control class normal distribution.

b. Homogeneity Test

Variance homogeneity test is intended to test the variance homogeneity between groups. Homogeneity test was carried out by F Test with criteria if $F_{count} \leq F_{table}$, then H_0 is accepted. Based on the calculations, the highest variance in the class control was 108.30 and the smallest variance in the experimental class was 83.45. Then from the F test results, the F the biggest/smallest variance = 108m30/83.45 = 1.298 was obtained. With significance level $\alpha = 0.05$ and numerator df = 40-1 = 39 and dimonitor df = 38-1 = 37, the value of Ftable = F_ (0.05 (39, 37)) = 1.71 was obtained. In fact, $F_{count} \leq F_{table}$ was 1.298 ≤ 1.71. ThereforeH_0 is accepted in the 5% significance level. Then, it can be concluded that the sample has a homogeneous variance. For more details, see the calculation results in Table 6.

Table 6. Homogeneity Test of Sample Class

Variance		α	F_{count}	F_{table}	Description
Experimental	Control				
83.45	108.30	0.05	1.298	1.71	Homogeneous

c. Hypothesis Testing

This hypothesis test is used to determine whether the mathematical problem solving abilities of students taught by the Creative Problem Solving learning model is higher than those who taught by direct learning model. This hypothesis testing conducted by t test, for normal data distribution and has a homogeneous variance. The result of the hypothesis test calculations is presented in Table 7.

Table 7. Differences in Average Results for Mathematical Problem Solving Ability Test of Students

Class	**N**	**Mean**	t_{count}	**df**	t_{table}
Experimental	40	70.13	3.43	76	1.665
Control	38	62.42			

In Table 7, it is obtained that t_{count} value (3.43) is higher than t_{table} (1.665). It means that H_0 is rejected or there are differences in mathematical problem solving ability of students that taught by Creative Problem Solving learning model and the direct learning model. The ability of students who taught by Creative Problem Solving learning model is higher than by direct learning model. In short, there is Creative Problem Solving learning model effect on mathematical problem solving ability of students.

2. Discussion

Based on the post test results, it showed that the mathematical problem solving ability of students grade XI IPA at SMAN 6 Jambi on the subject of statistics for experimental class that implemented creative problem solving learning model obtained the average score of 70.13, with a standard deviation of 9.13. The control class that implemented the direct learning model obtained the average score of 62.42 with a standard deviation of 10.41. Hypothesis testing was conducted by using one-tailed T test from the post test data of sample class. One-tailed T test was conducted in accordance with the hypothesis that had been formulated and based on the statistical calculation; it was obtained the t_{count} of 3.43 that was higher than t_{table} of 1,665 with the df of 76. This shows that the mathematical problem solving ability of students in the experimental class is higher than the control class.

The application of Creative Problem Solving learning model provides a learning variety to solve a problem through a systematic technique for organizing creative ideas. Therefore, it makes the students tend to be active and creative in using their thought to solve the given problem. In addition, the creative problem solving learning model makes the students to focus on problem solving skills, followed by strengthening the skills. As a result, when students are faced with a question, they may conduct problem solving skills to select and develop a response by expanding the thinking process. This method also trains the students to design a discovery, think and act creatively, solve the problem realistically, and make the education at school to be more relevant to the everyday life. Therefore, the students will be active, motivated and diligent in searching every problem faced. It is contrary to the direct learning model.

In the direct learning model, students will be passive since the teachers have an important role. Teachers are required to explain the material from the beginning to the end of the lesson to ensure that all students understand the materials. This may cause a student to be passive, accepting what is presented by the teacher, so that they will be lazy and bored to learn. Moreover, the teachers who always provide the subject material must always keep the image. It is because if they are not ready, lack of confidence, the students will be bored, then they will be lazy to learn. In addition, the material presented is complex and abstract so that it will make the students hard to understand the material because the teachers will not provide the opportunity for students to ask the questions. Also, this model will make the student lazy in learning because they know that the teacher will explain all the materials, including the solving of the problems or exercise given. In consequence, from the research results, it is reasonable that the students provided with creative problem solving learning model have higher ability compared to the students provided with the direct learning model.

V. Conclusion

Based on the results of this study, it can be concluded that the mathematical problem solving ability of students taught using creative problem solving learning model is higher than the students taught by direct learning model. This means that there are effects of creative problem solving learning model on the mathematical problem solving ability of students.

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