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THE TEACHING MODEL TO ENHANCE MATHEMATICAL PROBLEM SOLVING ABILITY IN JUNIOR HIGH SCHOOL TEACHER*

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Abstract

This study try out the teaching model of Mathematical Problem Solving (MPS) in Junior High School. The research design is in the form of experiment with pretest and posttest. Subject of study sample is 18 mathematic teachers in Junior High School in Jambi. The selection of teacher study is done by inviting their participation voluntarily. Teacher sample is selected in such manner that represent all class grades (I, II, and III) which come from Junior High School.

Treatment is given in stages, that is researcher teach MPS to teacher sample, then they teach MPS to students in their class. Treatment to teacher is given as much as 7 meetings by about 3 hour for each meeting. Treatment for student is implemented to teacher as sample subject in accord with each schedule and with the same material for each same class grade.

This study involve some kind of instruments, that is test for teacher as pretest and posttest, Likert model opinion scale and questionnaire about MPS for teacher, and 6 set of MPS test for student, each of 2 test sets (pretest and posttest) for student of class I, II, and III. Instrument for teacher is made by researcher, and this study for student is made by teacher and is reexamined together with researcher.

From result study, it is found that teacher's MPS learning outcome is categorized good, whereas student's MPS learning outcome is still categorized deficient, and teacher opinion about MPS tend to be positive. Further, it is found that MPS teaching give learning gain which is meaningful for class III students. Although teachers suggest their agreement toward MPS teaching in Junior High School, and there is score increment, teacher opinion about MPS is that the treatment do not give meaningful influence to positivity degree of teacher opinion toward MPS.

Keywords: The teaching model, Mathematical Solving Problem Ability, learning outcome

Introduction

Thinking process is much needed by people in solving numerous problems. In several things, it is possible that calculation problem can be solved by using counter aid which is simple or sophisticated. In contrary, thinking process in solving need certain intellectual ability which will organize strategy used in accord with data and problems faced. Intellectual ability such as above

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will train people to think critically, logically and creatively, where this kind of thinking is so much needed in facing the development of people who are increasingly complex.

The importance to select problem solving ability by student in mathematic is revealed by Branca (1980) as follow: 1) problem solving ability is the general aim of mathematic teaching, even as the heart of mathematic, 2) problem solving which comprise method, procedure, and strategy is a core and main process in mathematical curriculum, and 3) problem solving is basic ability in learning mathematic. As implication from opinion above, it is desire that problem solving ability is possessed by all children who learn mathematic from Elementary School and College level. Polya (1956) in his book "How to solve It" elaborate in detail four steps in problem solving accompanied by problem illustration, question¹⁵ which guide understanding of each steps, exercise problem, and solve it in mathematic. Those four steps¹⁶ are: 1) understanding the problem, 2) planning the problem solving or searching for alternative of problem solving, 3) implementing the plan or calculation, and 4) examining or testing the correct calculation or problem solving. Like Polya (1956), Novak (1977) reveal five activity sequences: 1) understanding the problem, 2) selecting or searching for the relevant knowledge, 3) selecting the possibility of problem solving, 4) processing the data, and 5) reassessing the problem.

Two researches (Utari, dkk, 1993): Utari in Sanusi (1993) by using test based on steps of problem solving from Polya, find that Junior High School skill is still low (Utari, 1993) and (Utari in Sanusi, 1993) in solving mathematical problem. The findings² above encourage the researcher to design a teaching learning model which can enhance the mathematical problem solving ability in Junior High School teacher. Rationally, if teacher have posses mathematical problem solving ability which is adequate, it is hoped that they can implement teaching which oriented on problem solving skill of their students. By noticing importance of mathematical problem solving possession for all who learn mathematic, so this study is felt increasingly needed to be implemented.

Problem formulation

The study try out the teaching model which can enhance subject mathematical problem solving skill. Treatment is given in stages, that is: researcher give treatment to several Junior High School mathematic teachers, who are taking advance study in Mathematic Education Study Program, and subsequently² they give the same treatment to students. Therefore, this study examine the treatment effect toward mathematical problem solving ability among Junior High School teacher and student.

In general, the success of one's learning outcome is influenced by their readiness to learn. There are two readiness to learn namely which is cognitive and affective. The readiness to learn cognitively among other is related with subject mastery toward knowledge and sort of learning which is relevant and ever studied by learning demand which is faced. The readiness to learn affectively among other is related with subject willingness to do learning, and subject perception toward object or process which is learned. In this study, the readiness to learn which is examined is limited by teacher subject.

Based on explanation above, this study want to reveal four main questions, namely:

- 1) How does the quality of mathematical problem solving learning outcome of Junior High School teacher and student, viewed on each step of problem solving in a whole and on each student's class grade?
- 2) Is there learning outcome which is meaningful about mathematical problem solving among Junior High School teacher and student, viewed on each steps of problem solving and in a whole and on each student's class grade?
- 3) Is there teacher opinion change toward teaching learning process of mathematical problem solving?
- 4) Is weakness and strength of teaching learning process of mathematical problem solving in Junior High School level?

The Aim of Study

The aim of study are:

- a) examine the mathematical problem solving outcome learning quality of Junior High School teacher and student, viewed on each solving steps, in a whole and on each student's class grade.
- b) examine the tendency and change of teacher opinion about teaching learning process approach of mathematical problem solving, after they get treatment.
- c) develop teaching model which can enhance mathematical problem solving ability among Junior High School teacher and student. In other words, this study examine the extent of learning gain achieved by teacher and student after treatment.
- d) examine the weakness and strength of teaching and learning process of mathematical problem solving in Junior High School.

The Advantage of Study

The discussion of teaching and learning process and learning outcome in problem solving in various subjects, especially mathematic, for student on various school level basically is very important. There are some reason which underlie the rationality above. First, the ability of problem solving is basically one of general aim of mathematic teaching, even as heart of mathematic. Second, problem solving is a core and main process in mathematic curriculum. Third, problem solving is basic ability in learning mathematic. Study about the development of problem solving Teaching and Learning Process can be tried out toward subject on each class grade and each student's cognitive stages, provided tailored with subject's readiness to learn. In this case, many kind of approaches can be developed about Teaching and Learning Process and also in arranging instrument to mathematical problem solving.

By examining the weakness and strength of problem solving teaching and learning process, and by considering the limitation of study time in school, this teaching and learning process can be tried out for certain topics which are essential topic. The mastery of problem solving skill is essential topic, can be developed by subject toward another topic, another subjects, even to act

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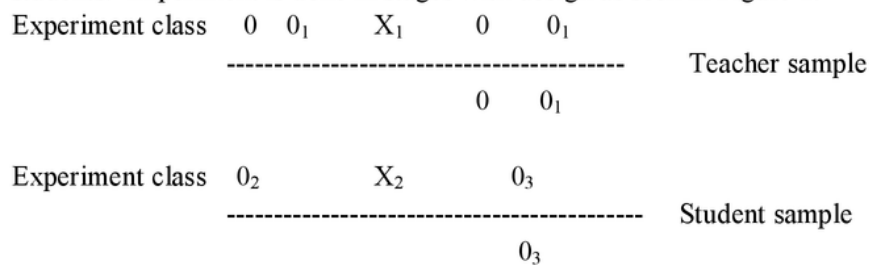
intelligently in daily life. Through problem solving Teaching and Learning Process, it is hoped that it will build learning attitude which is positive, creative and not easily give up in facing the challenge. The learning attitude above will give contribution to the tough personality, because basically, living in community is full of challenge.

In this study, problem solving Teaching and Learning Process is implemented toward teachers which is subsequently will be applied to their students. Therefore, this study give double advantages concurrently, that is enhance problem solving ability toward teacher and try to teach it to student which is hoped subsequently will enhance problem solving ability to their students.

Method of Study

Design and Sample of Study

This study is an experiment study which involve Junior High School mathematic teachers and their students. Experiment is done in stages with design as seen in Figure 1.



Annotation:

- 0 : Teacher opinion scale toward Problem Solving Teaching and Learning Process. 14
- 0₁ : Pretest and posttest of Mathematical Problem Solving (the same test) for teacher which is arranged by researcher. 14
- 0₂ : Pretest of Mathematical Problem Solving for student (consist of 3 sets, each set for each class, arranged by teacher and researcher).
- 0₃ : Posttest of Mathematical Problem Solving for student (consist of 3 sets, each set for each class, arranged by teacher and researcher). 13
- X₁ : Problem solving Teaching and Learning Process approach for teacher by researcher. 13
- X₂ : Problem solving Teaching and Learning Process approach for student by teacher.

Figure 1. Design of Study

To obtain the service quality toward teacher and carefulness degree in data analysis which is adequate, this study work with small size of teacher sample. Subject of sample consist of 18 Junior High School mathematic teachers and 806 of their students, with detail as in following table.

Table 1. Distribution of Study Sample Subject

Class	Experiment Group		Control Group	
	Teacher	Student*	Teacher	Student**
I	5	195	3	157
II	4	157	2	105
III	3	114	1	78
Total	12	466	6	340

Note: * One class of students from each teacher

** One class of students from teacher of control group plus 1 class of students from the same teacher in experiment group for class I, II, and III.

The selection of teacher sample subject of experiment group (12 teachers) is done by inviting participation of Junior High School mathematic teachers at the time they were taking continued education on Mathematic Education Study Program FKIP Universitas Jambi. From 12 teacher of experiment group, 3 teachers that is teacher of class I, II and III also teach students of control group. Teacher sample subject in control group (6 teachers) is selected by inviting participation (voluntarily) of mathematic teacher who teach the class from each subject of 12 experiment group in the same Junior High School. Therefore, students of 12 control class consist of 3 class of students who are taught by teachers of experiment group, and 6 class of students who are taught by teachers of control group; students of experiment group consist of 9 class of students from teachers of experiment group, and 3 class from teachers of experiment group who are accompanied by control group. Data processing of students from the three teachers of experiment group above is done separately from another experiment group.

Some reasons which underlie the way of teacher subject selection as such above are: (1) by taking teacher subject who are continuing study, make easier the implementation of treatment from researcher and do not disturb schedule of teaching activity of teacher subject; (2) by their participation voluntarily, subject will implement the program (treatment to their students) without feel compelled; (3) by taking teacher subject of control group from the same school with teacher of experiment group will decrease initial state diversity factor of student subject.

Treatment of Study

Experiment in this study is given with following stages:

- 1) Teacher subject is trained by developing mathematical problem solving Teaching and Learning Process approach. This training is conducted in 10 meetings in about 3-4 hours in each meeting. In this treatment, one papers and one set of handout is provided that contain the definition of problem solving, the plan of problem solving in mathematic Teaching and Learning Process, stages of problem solving, arranging and

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evaluating mathematical problem solving test, designing Teaching and Learning Process which is suit with students in class concerned.

- 2) Based on explanation in item 1) teacher subject arrange the test and MPS Teaching and Learning Process for their students. The test result which is arranged by teacher, then is discussed together with researcher, and edited by researcher to being prepared as teacher MPS posttest.
- 3) Based on test result for teacher, then the simplification of language is done in order to make it easier to be understood by student, and it is hoped that the amount decrease of test item is in accord with time available. Two set of MPS test is obtained for each student class grade (for pretest and posttest).
- 4) Teacher subject of experiment group implement the MPS Teaching and Learning Process approach for students in their own class, with the topic for each same class. Treatment from teacher is started by giving MPS pretest, and finished by MPS posttest. The monitoring toward Teaching and Learning Process implementation of experiment class teachers is done by giving questionnaire after posttest for student.

Teaching which is given by teachers of control group work as usual with topic which is the same as given by teacher subject of experiment group. The detail of topic which is given in this study are:

- 1) Set, mathematical sentence, angle equality and inequality, and count number for class I.
- 2) Pythagoras Theorem, comparison, periphery and width of rectangle, and parallelogram for class II.
- 3) Arithmetical, distance and time, circle, congruence, algebra operation, number line, equality and inequality for class III.

Because of pretest implementation in control group in several school was in the same time with another activity, result in pretest data which is incomplete. Subsequently, initial data of control group in this study is not processed.

Research Instrument and Its Development

This study involve 3 kind of instruments, namely: Mathematical Problem Solving Test (MPS test), Opinion Scale about MPS, and questionnaire for teacher about the implementation of MPS teaching. MPS test consist of 7 set, that is MPS pretest for teacher and 2 sets of MPS test for students of class I, II, and III Junior High School, each as pretest and posttest.

The development of instrument is done as follow:

1) Mathematical Problem Solving Test (MPS test)

a) MPS pretest for teacher subject

Test is arranged by special team for this study, based on steps of Polya (1954) and instrument model which is developed by IPSP (Schoen and Ohmke, 1980). Test material is selected about Junior High School mathematic with assumption that teacher subject have mastered test material well. Viewed from suitability between test syllabus and test item concerned, test show that it has adequate content validity.

b) MPS posttest for teacher, MPS pretest and posttest for student. MPS posttest for teacher which is also MPS pretest and posttest for student consist of 2 sets, and is arranged by teacher together with researcher during the treatment toward teacher. This procedure is implemented for several aims, that is:

- (1) as an effort to asses whether teacher subject have mastered how to arrange and asses MPS for student.
- (2) as MPS posttest for teacher subject.
- (3) to examine content validity and face validity of MPS test, especially for student.

MPS pretest about the material which have been taught by teacher before MPS is given and MPS posttest about the material which have been taught by teacher to student in teacher treatment toward student. Test is arranged based on steps of Polya (1954) and instrument model which is developed by IPSP (Schoen and Ohmke, 1980). Based on suitability between test syllabus and test item, MPS posttest for teacher which also MPS pretest and posttest for student, have owned adequate content and face validity. The reliability of MPS test for student of class I, II and III which is examined through Cronbach coefficient, obtain respectively as much as 0,48, 0,59, and 0,60 for pretest, and 0,76, 0,74, and 0,58 for posttest. The result above show that MPS test has reliability between high and medium and is viewed has adequately to be tested, show that test has test reliability coefficient which is adequate.

2) Opinion scale toward MPS Teaching and Learning Process.

Opinion scale consist of 3 sub scales that is about: (1) constructivism view in problem solving; (2) view about the way MPS should be taught; and (3) view that problem solving support the achievement of better understanding.

Scale development is done as follow:

- a) Scale is arranged in Likert Scale model in five choices. Scale is developed by modifying model of opinion scale in Pui Yee study (1993). Based on suitability between syllabus and item scale, opinion scale has own adequate content validity.
- b) Scale is tried out to 24 Junior High School teachers, to obtain the adequate items. Scale item which can be used is item which have response to five choice of answers (very disagree, disagree, neutral, agree, and very agree). Based on that criteria, from 42 scale items, as much as 38 items is selected that consist of 22 positive items and 16 negative items. Scoring for each choice of answer (5 choice) is done based on "normal deviation weighting from response category" (Edwards, 1969).
- c) Scale reliability is viewed from correlation coefficient of half method for even and odd item. The calculation yield coefficient $r = 0.67$ for half of test, and 0.81 for the whole test with $n = 24$ which show scale reliability which is adequate.

3) Questionnaire of MPS Teaching Implementation

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Questionnaire is addressed to teacher subject to obtain the feedback and information about the implementation of MPS Teaching and Learning Process which is implemented by teachers toward their students.

Data Analysis

Data analysis which is done in this study are:

- 1) The average calculation and standard deviation of mathematical problem solving test score for teacher and student in initial and final treatment, both in control class as well as experiment class, each steps of MPS and as a whole for each class grade.
- 2) The calculation of mathematical problem solving learning outcome among teacher and student in control and experiment group, each steps of MPS and as a whole for each class grade.
- 3) The average calculation and standard deviation of opinion scale score toward MPS Teaching and Learning Process for teacher in initial and final treatment, both in control class as well as experiment class, as a whole and based on class grade.
- 4) The calculation of teacher opinion change toward mathematical problem solving Teaching and Learning Process in control and experiment group as a whole and in each class grade.
- 5) Hypothesis testing of average differences of teacher MPS score, student MPS score, and teacher opinion toward MPS by using t statistic test, after normality testing of data distribution.

Conclusion

Based on result finding, this study give several varied conclusions. Some findings are:

- 1) About the quality of teacher and student mathematical problem solving (MPS) mastery; a) teacher MPS mastery who get MPS teaching is categorized good, but in contrary: b) viewed on each class grade and as a whole, Junior High School student MPS mastery especially class II is still unsatisfied. MPS process is still a difficult process for Junior High School student.
- 2) About MPS teaching and outcome among Junior High School teacher and student; a) viewed from aspect of understanding about MPS stages, the way how to arrange MPS exercise problem and test and also their scoring, MPS teaching among teacher give understanding enhancement of MPS process which is good; (b) viewed from initial and final state, MPS teaching for teacher give MPS learning gain which is meaningful, in other words, there is enhancement of teacher outcome learning in MPS; c) for student, although MPS learning outcome is still categorized unsatisfied about 44% from ideal score, MPS teaching give learning outcome which is meaningful among Junior High School students of class II and II, especially among group of clever students. Among students of class III, MPS teaching has not been given learning outcome enhancement which is meaningful. But, if it is viewed from magnitude of student percentage who achieve score above enough classification, MPS teaching among student give learning outcome enhancement which is meaningful.

- 3) About teacher opinion toward MPS teaching, and its implementation; a) viewed based in class grade and as a whole, teacher opinion about MPS teaching in Junior High School is categorized positive. Viewed among class grades, there is positivity degree enhancement of teacher opinion after MPS teaching, but in particularly MPS teaching has not been given positivity degree enhancement of teacher opinion toward MPS. The enhancement of positivity degree of teacher opinion “maybe” more determined by student’s maturity level from teacher concerned; b) although student learning outcome in MPS has not been satisfied, teacher agree with MPS teaching in Junior High School among other to: give variation of mathematical exercise problem, and encourage student to learn more active; c) the weakness and strength of MPS teaching in Junior High School. **Some obstacles in implementing MPS in Junior High School among other are:** problem form is still new for student. Student is not get used with MPS problem form; it is difficult for them to arrange MPS exercise/test problem especially for item which measure “searching solving alternative” stage; the implementation of MPS teaching need relatively longer time; in mathematical summative test and another subject teaching, problem solving process is not an aspect tested. **The strength of MPS teaching among other is:** give variation of new problem form so it is hoped that student is more creative and not boring, especially for clever student.

Implication and Suggestion

Although this study is viewed from multiple sides, this study give conclusion about MPS teaching in Junior High School which is varied, but the implication from study finding support the rationale that MPS teaching in Junior High School is one of teaching alternative form which can be implemented, developed, and refined further.

As follow up from this study, suggestions as follow is given:

- 1) MPS teaching is basically ever implemented by teacher in exercise/test, so some problem forms are familiar for students. The limitation of this study among other are, it need enough time to solve MPS problem form, student is not get used with MPS problem form, and limited study time because facing summative test preparation. Therefore, MPS teaching in Junior High School is need to get used, and developed further, by selecting relevant topics. This suggestion is basically a teaching plan though which can stimulate student thinking, and oriented on challenge in the future.
- 2) Suggestion for the next study. In general, MPS process is still difficult aspect for Junior High School students. Nevertheless, MPS process aspect is important aspect in learning mathematic. MPS process involve several aspect of lower prerequisite process. There is possibility that student learning outcome related with student learning outcome structure stage. Therefore, it is suggested that a study is conducted about relatedness of student learning outcome learning stage in mathematic and MPS mastery, and study about mathematic teaching alternative which make possible the enhancement of student learning outcome structure and another higher cognitive aspect for various school level and student cleverness level.

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