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An analysis of mathematical problem solving ability based on hard work character in mathematics learning using connecting organizing reflecting extending model

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Abstract

Mathematical problem-solving ability is one of the goals of mathematics learning. However, the mathematical problem-solving ability of students is still lacking. Therefore, this research was conducted (1) to observe whether students problem-solving ability on CORE-modeled mathematical learning passed the minimum criteria of mastery learning or called as *KKM* included average mastery and proportion mastery, (2) compare the application of CORE model and Jigsaw model on students problem solving ability, (3) increase the mathematical problems solving ability using CORE model and (4) analyze the mathematical problem solving ability observed from hard work character using CORE model. This research used a mixed method with the concurrent triangulation method. The population was VIII grade student of SMPN 12 Semarang. The results showed that: (1) the mathematical problems solving ability on CORE-modeled mathematical learning passed the minimum criteria of mastery learning included average mastery and proportion mastery, (2) students problem solving ability on CORE mathematics learning model and those on Jigsaw mathematics learning model are equal, (3) there was an increase in the mathematical problems solving ability on mathematics learning after CORE model being applied, (4) student who had worked hard trait in the 1st group on mathematics learning showed the ability to solve mathematical problems was better than those in 2nd and 3rd group on mathematics learning.

1. Introduction

Mathematics is one of the essential lessons to learn since elementary school until high school because of its purposes. One of the mathematics learning purposes is students are expected to acquire problem-solving ability including the ability to understand a problem, devise a mathematical model, solve the model and interpret the obtained solution (BSNP, 2006).

In mathematics, Indonesia students are still having low problem-solving ability compared to other countries. One measure which proves this fact is the result of the Trends in Mathematics and Science Study (TIMSS), an each four-year surveys conducted since 1995. During Indonesia's survey, Indonesia always get the average value score below the international average that is 500. TIMSS survey results are presented in the following table.

Table 1. TIMSS Survey Results

Year	Score	Ranked
2007	397	36 of 49
2011	386	38 of 42

Mullis et al. (2012) reveals that VIII grade students who participate in the TIMSS survey have a very low ability in mathematics significantly.The percentage shows very low ability student with estimates exceed 15% but never surpassed 25%.

Before the study of mathematical problem solving ability of students of class VIII done first observation about the pre-study the form of mathematical problem solving abilities in one class VIII SMPN 12 Semarang. The given problem is Citra and Zaki are cycling at the same speed. The mileage they travel after minutes can be expressed

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by function $h(x) = x^2 + 8x - 5$ (meter). After a minute, Citra stops cycling. The distance covered during the minute Citra is. Zaki stops cycling some minutes later and distances. How long is each Citra and Zaki cycling?

The preresearch obtained from the observation that the mathematical problem solving ability has not reached the actual completeness limit either average or proportion. The actual completeness limit which is determined based on the average value $(\bar{x})$ has been accomplished group of student and standard deviation (s) in this group (Sudjana, 2009).

Warli & Fidiana (2015) state that problem solving ability becomes a vital part of learning that must be developed. Again, Heh (1999) argues that the problem solving is a kind of representation of thought. It is a way to overcome all kinds of difficulties and obstacles. From a variety of those opinions, it can be concluded that the problem-solving ability is an ability to solve problems or obstacles which can be trained through mathematics learning.

Setyobudhi (2012) explains that mathematics in Indonesia still emphasizes on memorizing formulas and calculating. Not even a few teachers are still authoritarian to emphasize the existing formulas without explaining. Driana (2012) also reveals that the mathematics learning in Indonesia is still focused on the exercises consequently the learning will not be fun let alone thrive. That is why only a few students like mathematics. As TIMSS survey in 2011 reports that only 20% of whole students who liked mathematics, 70% a bit like learning math and the rest does not like it at all (Mullis et al., 2012). Therefore, it is urgently needed to make math learning becomes more fun and interesting in order to achieve mathematics goals.

One of the goals of mathematics learning is that student have the problem-solving abilities. Polya (1957explains that there are four steps that must be done that students must do, as follows (1) understanding the problem, (2) determining the plan, (3) carrying out the plan, and (4) looking back.

NCTM (2000) explains that student must learn mathematics with understanding, actively construct new knowledge from the experience and knowledge they have previously learned. This is in line with the learning model CORE (Connecting, Organizing, Reflecting, Extending) which involves student to connect and organize previous knowledge to gain new knowledge. So it is expected that the students problem solving ability will increase after learning by using CORE learning model.

Student's mathematical problem solving ability which is still weak needs to be assessed so that the teacher can improve mathematical problem solving ability to see the character of students' hard work in mathematics. Based on the preliminary explanation, this research analyzes the mathematical problem solving ability in terms of students' hard work character in mathematics by using CORE (Connecting, Organizing, Reflecting, and Extending) learning model.

In solving math problems, some students tend to give up due to their assumption that mathematics is a difficult subject. Then, hard work character refers to the character unyielding attitude affects a person in the act. Besides, the Ministry of Education and Culture (2010) strengthens that hard work character is one of characters which is developed through cultural education and national character. However, this research points out the hard work character as the behavior that shows the effort in earnest in solving problem, obstacles and tasks as well as possible in mathematics learning. Nevertheless, the teacher has not noticed students' hard work character, even though hard work is one of the characteristics which determines success. As Larch *et al*. (2014) reveal that the hard work is an action that plays a vital role to enable success.

Most of previous research observed students' problem solving ability on CORE mathematics learning model. Meanwhile, this research observes students' problem solving ability on CORE model viewed from students' hard work character.

Based on the background of the problems, there are several research problems, as follows (1) whether the students' ability of solving mathematical problem with CORE learning model has reached the limit of completeness actual on average and proportion, (2) whether students' problem solving ability on CORE learning model over the learning model at school observed (Jigsaw) is equal, (3) whether there is an increased problem-solving ability of students after using CORE learning model, and (4) how the description

of mathematical problem solving ability of students in terms of hard work character in mathematics is.

Regarding to the research problems, this research aims (1) to observe whether students problem-solving ability on CORE mathematics learning model passed the minimum criteria of mastery learning or called as *KKM* included average and proportion mastery, (2) to compare the application of CORE and Jigsaw learning model on students problem solving ability, (3) to increase the mathematical problems solving ability by using CORE learning model and (4) to analyze the mathematical problem solving ability viewed from students' hard work character by using CORE model.

Furthermore, the hypothesis of this study are (1) the mathematical problem solving ability by using CORE learning model can achieve real mastery limit on average at 57 and the proportion at 75% of the number of students, (2) the comparison between the students' mathematical problem solving ability by using CORE learning model and those by Jigsaw learning model, (3) there is an increase in the students' mathematical problem solving ability after getting the learning by using CORE learning model.

In the end, the results of this study are expected to be one of teacher's references in guiding and improving mathematical problem solving ability based on hardwork character and able to help students to improve mathematical problem solving ability and hard work character.

2. Method

This study used a mix method. The population in this study was students of VIII grade SMPN 12 Semarang in the second semester of the academic year 2017/2018. Further, the samples were taken by random cluster sampling technique. VIII A class was selected as the experiment class which was taught by using CORE learning model and VIII C as the control class which used the common learning model namely Jigsaw learning model. The selection was caused by the equal mathematics of students of SMPN 12 Semarang,

Before choosing a research subject, the researcher firstly divided the classification of hard work characters. It consisted of group 1 was the students with high criteria in completing all mathematics tasks in advance, being highly ambitious to obtain the mathematics knowledge as much as they can, and trying to manage their times well to study mathematics. While group 2 and group 3 were the students with the character of hard work in learning mathematics in a row in medium and low criteria in resolving all mathematical tasks on time, trying to acquire mathematical knowledge as much as possible, and using the time as well as possible to learn mathematics. The subjects of research for each interview were selected two from each group classification.

The next step was compiling the research instrument, such as mathematical problem solving ability test, character questionnaires of hardwork in mathematics learning, interview guidelines and research tools in the form of syllabus and lesson plan. The instruments and research tools were previously validated by the experts then used after the revision was completed. After being revised, a trial was conducted to problem solving ability test and hard work character questionnaires in the learning, so it could be implemented in the research. The result of test was 7 of 8 question valid with medium reliability. The result questionnaires of hardwork trail was 100% valid and high reliability category.

The research design was quasi-experimental design with pretest-posttest control group design, where there were two groups with a experimental group and a control class. The quantitative research design which was used in this study is presented on the following table.

Table 2. The Research Design of pretest-posttest

Class	Pretest	Implementation	Posttest
Experimental	O_1	X	O_3
Control	O_2	K	O_4

Information:
O_1 : Pre-test of the experimental class
O_2 : Pre-test of the control class
X : Learning CORE
K : Learning Jigsaw
O_3 : Post-test of the experimental class
O_4 : Post-test of the control class

In this research, the learning was conducted fourtimes in the experimental class by using a model of CORE (Connecting, Organizing, Reflecting, and Extending) and control class by using Jigsaw model. The material used was the geometrical surface area of the flat side. The variables used were the independent and the dependent variable. The variables for hypothesis I and III were CORE learning model (independent variable) and mathematical problem solving ability

(the dependent variable). While variables for hypothesis II were CORE learning model and Jigsaw as the independent variable and mathematical problem solving ability as the dependent variable.

The data collection techniques used in this study were (1) the documentation which was used to obtain the data relating to the research which was in the form of worksheets of students, lesson plan, and quiz, (2) the interviews which were conducted twice in order to determine the initial and final conditions to obtain the response data of students in mathematical problem solving ability tests, (3) the written test in the form of pretest and posttest, and (4) the questionnaire of students; hard work character in mathematics.

Meanwhile the mechanical analysis of quantitative data which were used were (1) the analysis of initial data pre-requisite test in the form of normality, homogeneity and a same average test, (2) the analysis of the final data in the form of test preconditions including normality test to determine the statistical parametric and nonparamateric used, the homogeneity test to determine the statistical test used, hypothesis I test was used *t*test to test the attainment of limit the thoroughness of its actual average and *z*test to test the attainment limit the thoroughness of its actual proportions, the hypothesis II used the *t*test and *z*test to test the differences mathematical problem solving ability with CORE and Jigsaw learning model on average and proportions, and the hypothesis III used *t*-test gain was to determine the increase in mathematical problem solving ability of students in the CORE learning model class.

The analysis of qualitative data used came from interviews. The interviews analysis was done by reducing the data, presenting data and drawing the conclusions. The reducing data process was to throw the data which were not related to the research topic in the dorm of chat-talk, personal stories, subjetcts' hobbies, so that the data only focused interviews related to research topic. The presentation of data used several images of test result and interview of mathematical problem solving ability. Then, the drawing conclusion process about mathematical problem solving based on hardwork character in mathematics learning. While the data validation was done by triangulation technique that compares the test data with mathematical problem solving ability and interview data.

3. Results and Discussions

3.1. *Preliminary Data Analysis*

Preliminary data experimental class and control class derived from the value of pre-test of mathematical problem solving ability which was done in VIII A, VIII B, and VIII C. The three classes were the classes which were taught by teachers who were entrusted to receive investigators. The analysis of normality using the Kolmogorov-Smirnov test with a significance level 5% indicates that the data are normally distributed population and homogenous. The average similarity analysis of three classes by using one way ANOVA shows that the three classes have the same average. Based on the results, VIII A is determined as the experimental class while VIII C as the control class.

3.2. *Mathematical Problem Solving Ability Using Connecting Organizing Reflecting Extending*

Before the hypothesis test against the final data was conducted, the researcher did prerequisite test in the form of normality and homogeneity test. For hypothesis I posttest data, such as the results of mathematical problem solving ability CORE class learning model shows that the data are normally distributed, so it can be used as the parametric statistical tests. For hypothesis II, the data which came from a posttest results with CORE and Jigsaw learning models are normally distributed population so that it can use as the parametric statistical tests. Additionally, the data are also homogeneous so it can use for the t test. For hypothesis III data such as the results of pretest and posttest class mathematical problem solving ability with CORE learning model indicate that the data came from a normal distributed population yet not homogeneous, so it can be used as the parametric statistical test namely the *t* test.

Firstly, the hypothesis test I was done by testing the completeness of the average right side and proportions right side test. The data used were posttest CORE learning model. The results of calculations for the average test are $t_{count} = 6{,}805 > 1{,}6866 = t_{table}$ and the right side shows the proportion of test calculation result $z_{count} = 1{,}709 > 1{,}645 = z_{table}$. In brief, the hypothesis test I shows that H_0 is rejected or mathematical problem solving ability classes using CORE model has reached the actual completness limit in average and proportion.

Secondly, the hypothesis test II was conducted by using the average difference test and

proportions differences test. The data used were the posttest CORE and Jigsaw learning model. The results of calculations of the average difference test are $t_{count} = 0{,}5720571 < 1{,}67 = t_{1-\alpha}$ and the results of calculations of proportion differences test are $z_{count} = 0{,}006692 \leq 1{,}64 = z_{table}$. Based on those results, hypothesis test II indicates that H_0 is accepted or mathematical problem solving ability of CORE learning model class is less than or equal to the Jigsaw model either average or proportion test. Therefore, the further tests were carried out in the form of a mean similarity test and proportion similarity test. The tests report that the mathematical class problem solving ability with the CORE learning model is same as the Jigsaw learning model class.

Then, the hypothesis test III was performed by using the normalized gain criteria and *t* test. The normalized gain criteria was used to determine the increase in mathematical problem solving ability after giving the learning by using CORE learning model. While the *t* test was used to determine whether there are differences in mathematical problem solving ability after obtaining CORE learning or not. In this hypothesis, the data used were pretest and posttest CORE learning model. The result shows the normalized gain calculation criteria $\langle g \rangle = 0{,}524585$ that would meaning the magnitude of the increase in medium category. The individual improvement in presented in the following table.

Table 3. The individual improvement of mathematical problem solving

Criteria	Many Students	Percentage
High	7	21.21%
moderate	22	66.67%
Low	4	12.12%

The results of the *t* test is $t' = 7{,}1246225 < 2{,}0378 = t_{1-\alpha}$. Thus, H_0 is rejected or mathematical problem solving ability after obtaining CORE learning model is more than before gaining CORE learning model.

Based on the results mentioned, it can be concluded that (1) the mathematical problem solving ability by using CORE learning model has reached the actual completnees limit, average and proportion, (2) the mathematical problem solving ability by using CORE learning model class (the experimental class) is equal to the Jigsaw learning model class (control class), (3) there is an increase in mathematical problem solving ability with medium category after receiving CORE learning model.

Apparently, these research results are in line with Surya, et al (2017) research which shows that there is a relationship between the use of learning model and mathematical problem solving ability. The result is based on the analysis of the improvement of mathematical problem solving ability after the implementation of CORE learning model. Then, a research result by Utami (2017) which shows that the implementation of the CORE learning model at the end of each indicator test troubleshooting gets more values with a percentage of 96.87% with CORE learning model achievement of 97.22%. Similarly, Anggraini (2015) states that the class with CORE learning model has successfully reached 7,5 the classical completeness and effective in achieving the mathematical problem solving ability.

The instruction of CORE (Connecting, Organizing, Reflecting, and Extending) learning model is very reliable as a basis in the learning stages as easily be applied to all subjects and the emphasis is on cognitive strategy approach to all subjects (Calfee, 2010). Jacob (2011) reinforced that the use of the CORE model supports students in learning activities since each step students are encouraged to take an active role in connecting their selves to learn (Connecting), organize the materials that have been obtained by discussing in groups (Organizing), reflecting the material they have learned in class (Reflecting) and broaden students' knowledge (Extending).

The mathematical problems solving ability by using CORE learning model (the experimental class) is equal to the Jigsaw class (the control class) since both of CORE and Jigsaw have a good effect of mathematics. Nurcahyo (2016) supports that that the cooperative Jigsaw learning model affects on problem-solving ability of VIII grade. The use of CORE and Jigsaw learning model is equally well used in the study of mathematics which has a good effect on the ability of mathematical problem solving.

Regarding to the explanation it can be concluded that there is a suitable not the best learning model for particular materials. For instance as research conducted by Savitri et al. (2013) reveals that the learning material Missouri Mathematics Project at the quadrilateral of the mathematical problem solving ability achieves mastery in proportion. Similarly, a study conducted by Ariyani et al. (2013) on the material rectangles indicates that the average problem-

solving ability of students who are the subjects of MMP can achieve mastery learning.

The results of this research show an increase in mathematical problem solving ability after CORE learning model applied. This result is relevant to Utami's (2017) research which shows that the implementation of the CORE learning model can improve the ability of mathematical problem solving. Again, the research conducted by Khafidhoh (2014) also shows that the CORE learning model is able to improve mathematical problem solving ability of students. In addition, Aziz et al. (2012) also reveal that the CORE learning model is able to improve mathematical connections. So it can be said that CORE learning model positively can improve students' learning outcomes in learning mathematics.

3.3. *Mathematical Problem Solving Ability Based on Hardwork Character in Mathematics Learning*

Hard work is one of motivating factors of success. Aithal & Aithal (2016) reveal that students who learn with hard work character have better learning outcomes than students who studied at the last minute before the exam. Therefore, this research elaborates mathematical problem solving ability and hard work character.

After conducting the research and analysis of quantitative data, it was obtained the answer the research problem number four that is the description of mathematical problem solving ability of students in terms of hard work character in mathematics by using CORE learning model. There were two selected students from each hard work character group.

Furthermore, based on test data on the mathematical problem solving ability of each indicator and the results of interviews with six research subjects, then the triangulation technique was carried out. The triangulation technique in this study compares the test data with the mathematical problem solving ability and interview data.

First, the students in group 1 were able to work on the problems with the indicator to understand the problem, determine the settlement plan, implement appropriate settlement plan and to re-examine the results of the work presented, although sometimes they were care less in calculating. Second, the students in group 2 had difficulties in re-examine the results of the work presented. Third, students in group 3 still have difficulties in determining a plan, executing the settlement according to the plan and re-examining the results of the work.

The students who have high hard work character always completed the task in advance. They also collected the assignments, homework and quizzes in a timely manner. Their works collected were also complete.

During the learning process, the high hard work character students really tried to get as much mathematics knowledge as they can. They also always asked if there were any material they did not understand yet. Additionally, they also actively participated in group discussion and presented the group discussion result in front of the class.

Those students were able to understand the problems, determine a plan to solve the problems, implement the settlement according to plan, and re-examine the results of the work.

Similarly, the students with medium hard work character were also able to complete all the task on time, manage the time to learn mathematics, understand the problem, determine the plan to solve the problems, and execute the solution as planned. Unfortunately, they still got difficulties in re-examining the indicators.

The students with low hard work characters tend to ignore the task during the learning process. They often did not submit the assignments, homework, and quizzes. Additionally, they did not give their best effort to gain as much knowledge as they can. They also wrote the wrong formula. Apparently, they had incomplete notes and only used a notebook to study.

During the learning process, students with low hard work character used their best time to learn mathematics. But, based on the interview, they thought that they did not need to recall or repeat the lessons at home, even more they did not ask the material they had not understood. Therefore, they got difficulties in understanding the problems, determining a plan to solve the problems, implementing the settlement according to plan and re-examining the results of the work. Hence, it is necessary to develop or increase their hard work character so their mathematical problem solving ability will also increase

The results above are in accordance with several previous researches. First, Taneo et al. (2015) states that the high hard work character students have better mathematical problem-solving abilities than the middle and low group. It means that if the hard work character is high so the mathematical problem solving will be. Ibrahim (2017) also explains that the high hard work students are able to achieve all the indicators of

problem solving without any troubles, the middle group students are also able to achieve all indicators but still have a little error, while the low group students are less able to reach several indicators and still get difficulties since they are lazy to read, understand the concept and recall the material which have been taught.

From the explanation above, we can see that if the students hard work character increase so their mathematical problem solving ability will be. Thus, it is necessary to apply an appropriate learning strategy which in accordance to the initial students' learning motivation (Fitriastuti, 2014).

4. Conclusion

Based on the findings and discussion, there are several conclusion which can be drawn, as follows, (1) the ability of mathematical problems soling by using CORE learning model has reached the limits of its completeness actual average and proportion. (2) The mathematical problems solving ability by using CORE learning model (the experimental group) is equal to the jigsaw learning model (the control group) (3) there is an increase in students mathematical problem solving ability after receiving CORE learning model (4) the high hard work students have much better mathematical problem solving ability than the middle and low hard work students.

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